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THE TERRESTRIAL GLOBE AT THE PARIS EXPOSITION.

THE construction of a terrestrial globe is certainly not a new idea, but a globe to a millionth, that is to say, measuring forty meters in circumference, constitutes a unique work of its kind, and one which deserves to attract the curiosity of the public and particularly the attention of the learned world.

In order to demonstrate the utility of this interesting work before beginning a description of it, it will suffice to cite a few extracts from the pamphlet that the authors of the project published at the time of the formation of the scientific committee of patronage.

Maps projected upon plane surfaces destroy the idea of the earth's rotundity, and the diversity of their scales renders comparison between the extents represented very difficult. As for globes, they are usually much too small to establish, even in imagination, any relation with the real dimensions.

The indications that the makers are led to inscribe upon them tend even to give false ideas as to certain data, such as the surface of cities, the width of rivers, the height of mountains, etc. It would therefore be interesting to avoid these two inconveniences by constructing a globe whose dimensions would be sufficient to offer all the advantages of the geographical maps established on a common scale, and, at the same time, to give a more appreciable relation with the size of the earth. A globe on the scale of a millionth is capable of fulfilling such conditions.

Our metrical inch is the forty millionth part of the meridian. This globe will be forty meters in circumference, and one kilometer will be represented by one millimeter. On this scale, the geographical details can be sufficiently well indicated and will appear, for the most part, in their true measurement. We shall see for the first time upon a globe the place really occupied by certain spaces of known dimensions, such as those of the larger cities. Paris will occupy upon it nearly a centimeter.

Continuing the demonstration of the utility of the work from other points of view, the authors terminate thus: This sphere, remaining for the moment in the more modest domain of geography, will assuredly be full of instruction. At the Universal Exposition of 1889 it will dedicate a sort of centenary of the foundation of our metrical system, while, at the same time, it will illumine one of the greatest works of the age by the indication of the system of maritime and terrestrial ways of communication with which the globe has been covered for a hundred years past.

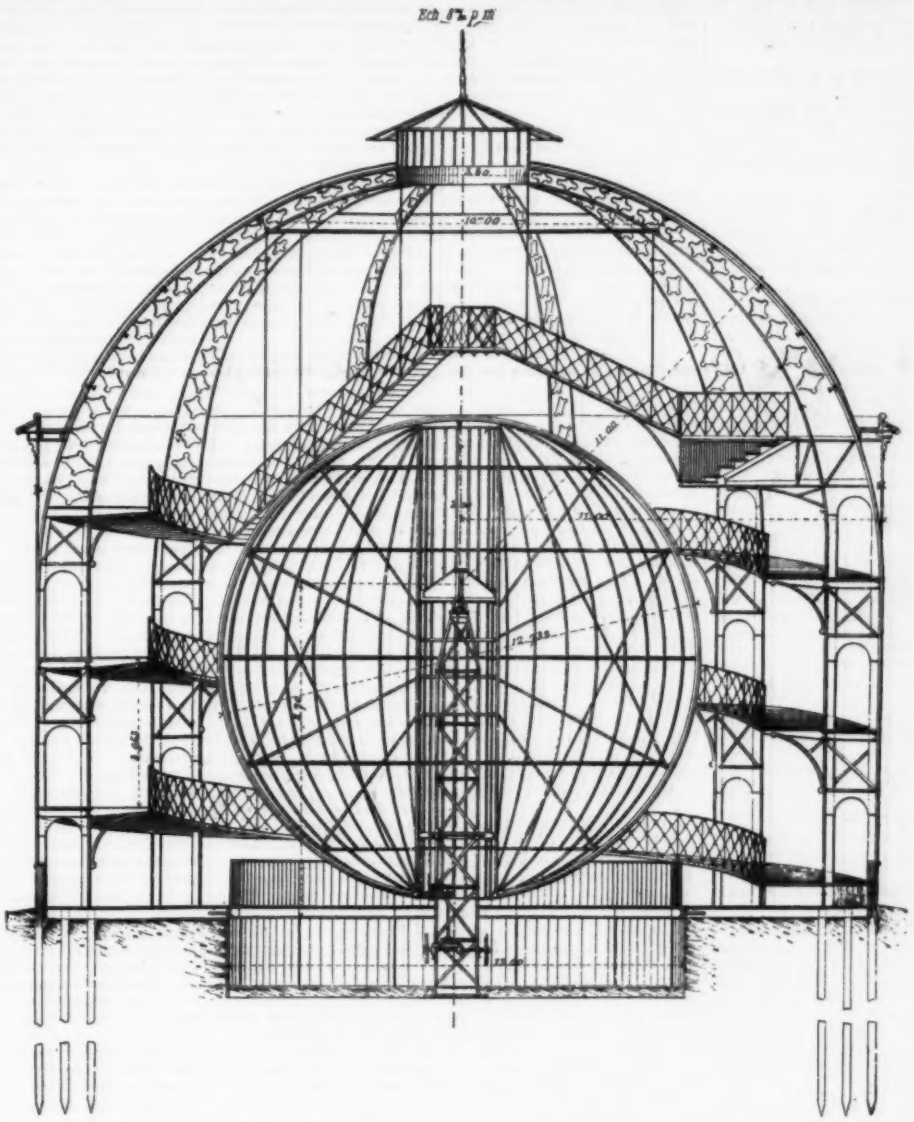
Let us now enter upon our subject—the construction of the globe and the building that protects it.

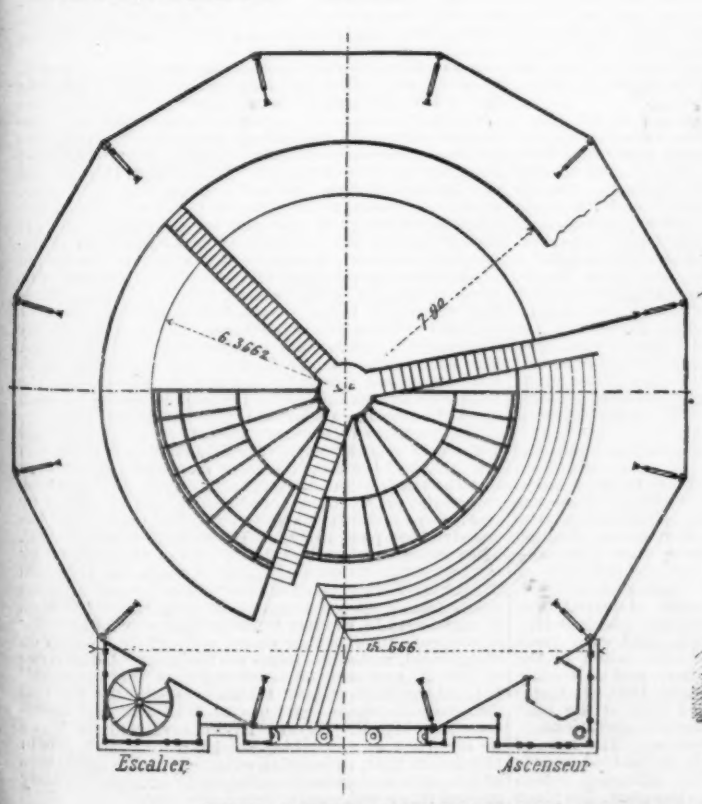
Framework of the Globe.—The globe is 40 meters in circumference and 12·73 meters in diameter. It revolves around a vertical axis, and to this effect is provided with a pivot situated 1·5 meter above its center.

The pivot turns in a bearing supported by a framework 10 meters in height.

The framework of the globe is wholly of iron, and consists of 20 semi-meridians connected with each other by five parallel angle iron rings. Each semi-meridian consists of a curved angle iron whose extremities are connected by a straight angle iron. In the plane of the semi-meridian thus formed are arranged 5 radiating angle irons cross-braced by an angle iron and a flat iron placed crosswise.

These 20 semi-meridians are grouped symmetrically around two rings of iron plate and angle iron, 2 meters in





THE PARIS EXHIBITION—THE GREAT TERRESTRIAL GLOBE AND BUILDING.

diameter. The vertical angle irons, thus arranged conformably to the generatrices of a cylinder, constitute what may be called the central "core" of the globe, and which carries a special ring to which the pivot is bolted.

Twenty other semi-meridians, formed simply of a curved angle iron, are interposed between the others. They are fixed upon parallels and extend to the extreme parallels. All the meridians are provided with a furring of wood.

These meridians and parallels collectively constitute the framework of the sphere, which is extremely light.

The pivot is of iron, and its point is of steel. It revolves in a cast iron bearing with a bronze bushing. The bearing is supported by a frame with a square base formed of four uprights crossbraced by angle irons which are connected with each other by flat and angle iron diagonals. This frame carries the measuring apparatus designed to give the sphere its rotary motion, and which consists of two hand wheels and a pair of bevel wheels that transmit motion, through the intermedium of gearing, to a cogwheel bolted to the central core of the sphere.

The gearings have been so calculated as to allow the sphere to be revolved by one person.

In order that the axis of the globe may be kept perfectly vertical during the maneuvering, there are arranged at the angles of the supporting frame four rollers, which, in revolving, bear against a ring formed of U iron and fixed to the central core.

Surface of the Globe.—The surface of the sphere is formed by the juxtaposition of 585 strips of cardboard all curved uniformly in conformity with the spherical surface of 6·36 meters radius, and cut into curvilinear trapeziums of which two of the sides are meridians and the other two parallels.

The moulding of each piece was done with the utmost accuracy according to an outline made upon a spherical mould. Each piece of cardboard is coated with a mixture of Meudon white and glue size. The coating, from 3 to 4 millimeters in thickness, was laid on in several coats, spread out with a curved template, dried in a stove, and then pumiced. This mode of manufacture, which appears quite simple at first sight, nevertheless required great care on the part of Mr. Ikelmer, to whom this part of the work was intrusted.

The pieces thus formed are fixed upon wooden supports which are screwed to the furring of the meridians.

Painting —The globe is painted in oil, the paint being applied directly to the cardboard pieces before mounting.

In addition to the representation of the continents, the relief of the earth, and the watercourses, there will be shown the lines of navigation, railroads, submarine cables, the depths of the ocean, the currents, the tracks of the voyages of celebrated explorers, etc.

In order to give an idea of the precision and care applied in the execution of this work, we shall follow, in their sequence, the different operations that had to be performed.

In the first place there was laid out on tracing paper an outline corresponding to each piece of cardboard, and in the preparation of each outline the best maps and the most recent documents that geographical science possesses were consulted. These outlines were stretched upon curved boards, which served as drawing boards. On them were traced the contour and the division in degrees. The sketch finished, the details were transferred to the cardboard by means of transfer paper of different colors.

It was upon these outlines thus reproduced by transfer upon the cardboard that the painters exerted their talent, and taxed their ingenuity to render sensible to the spectator's eye, through effects of light and shade, the reliefs of our planet—bringing into prominence, by light colors, the high plateaux, and showing the deep valleys by vigorous tones, while at the same time preserving the relative importance of each, and selecting for each region the shade that best becomes its general aspect. The *ensemble* of the color is most happy, and possesses a certain freshness that pleases the eye and impresses it agreeably.

The Building.—The pavilion for the globe is situated on the side of Suffren Avenue, between the Palace of Liberal Arts and the Children's Palace. It consists of six iron trusses of extreme lightness, connected by metallic girders and trimmers. These corners of angle iron and iron plate interties, arranged spirally, serve as supports to a helicoidal gallery ingeniously arranged in such a way as to permit visitors to see every part of the globe by an easy descent from the gallery to the pit beneath the Antarctic pole.

The trusses are provided with brackets that carry the interior helix. These trusses are assembled at the top by an angle iron and iron plate ring surmounted by a cupola. The sides of the building are of wood, with large windows reaching down to the foundation wall.

The forepart of the building consists of two towers and a central bay. The interior of the towers is so arranged that a staircase can be put in one of them, and an Otis elevator in the other, which latter will carry the visitors to a gallery whence they will get their first view of the globe. From the gallery starts the spiral that permits of seeing the continents, save the polar regions, more in detail. To see these last named regions, a threeway footbridge is provided, one of whose branches starts from the gallery and the two others from the helix.—*Le Genie Civil.*

THE GREAT DESERTS OF THE EARTH.

By JOSEPH F. JAMES, M.G.

MR. ALFRED WALLACE, in his interesting book on "Island Life," considers it probable that the present ocean basins and land masses have occupied nearly their present positions since very early in geological history. He shows that the average elevation of the land and the average depth of the sea is such that it is extremely improbable that at any period in the history of the earth were there any oceans comparable in depth to the Atlantic or Pacific where the continents now are. That there were fluctuations in size is probable; and that the continents have gradually increased in extent is also likely; but it may be considered, for all practical purposes, that the position of the land and water masses is permanent.

Investigation of the general arrangement of mountains and plains on continents brings several facts into prominence. First of these is that the margins of great land masses are generally occupied by mountain ranges of greater or less extent; second, that the greater mountain range is nearest the larger ocean; and, third, that the continent between the two mountain systems is occupied by more or less level plains, plateaux, or deserts. Take the South American continent as an example. The great range of the Andes follows the western shore of the continent at an average distance of only fifty miles, facing the basin of the Pacific, which stretches westward for ten thousand miles. The eastern border of the continent bears the smaller chain of Brazilian mountains, facing the Atlantic ocean, less than three thousand miles in extent. The interior of the country is occupied by the vast valley of the Amazon, a nearly level plain extending two thousand miles from east to west, and stretching almost from the Caribbean Sea to the plains of Patagonia. In this instance the interior plain is fertile. For though dried up in summer, both at the north and south, in the season of rains it produces an abundant vegetation, and is capable of supporting immense herds of horses and cattle. The valley of the Amazon proper is not subject to these changes, but preserves an aspect of perpetual verdure which cannot be paralleled outside of the tropics. Examination of other continents reveals similar features—ranges of mountains near the shores, plains of one character or another between the two.

We are concerned on the present occasion with none but those barren wastes which often occupy vast areas of land known as deserts; places where vegetation is generally absent, and where, if found, it presents peculiar features; where sand is the prevailing soil; where heat or cold, and sometimes both, contend for mastery; and where many a human being and many a beast of burden has lain down to die. The Arctic zone has claimed a large quota of human beings, but the tropics has far surpassed it in the number of its victims. In the one case counted by hundreds, in the other they mount up into the thousands.

The desert region of South America is one which was, perhaps, known to Europeans long before any other in the western world. The Puna, as it is called, occupies a tract of land extending for three hundred and fifty Spanish miles between the Andes and the Cordilleras at an elevation of twelve thousand feet. It spreads over nearly the whole of Peru, from northeast to southwest, through Bolivia, and eastward into the Argentine Republic. The climate is rigorous. Winds blow from the west and southwest nearly all the year round, bringing from the snow-capped Cordilleras icy cold weather. During four months of the year the storms are accompanied by thunder, lightning, and snow. The average height of the thermometer in the cold season (strangely called summer because it seldom snows!) is, during the night, 12° F., and at midday about 50° F. In winter, or the warm season, the mercury seldom falls below freezing during the night, but at noon it is only about 45° F. The temperature, however, is so uncertain that it will sometimes vary 40° in a few hours. This change is more severely felt on the fall of temperature, as it is accompanied by keen, biting winds which cut the face and hands, but which have so remarkable a drying effect that in a few days a dead body is converted into a mummy, and no sign of decomposition is to be observed.

A feature not the least remarkable of all the meteorological conditions of the Puna is the occurrence of alternate streams of warm and cold air. After traversing a space where biting winds prevail, there comes a warm atmospheric current which varies in width from two or three paces to several hundred feet. These streams run parallel to each other, and travelers sometimes pass through five or six of them in a few hours. They seem to be most frequent in August and September, and generally follow the direction of the Cordilleras. Von Tschudi states that he once traveled several leagues through a succession of these currents of warm air, none of which exceeded twenty-seven paces in width. Their temperature was 20° F. higher than the adjacent atmosphere. It would seem that they are not temporary currents, for the mule drivers can often foretell about where they will be encountered.

The aspect of the Puna is dreary and monotonous. The ground is covered by yellowish-brown grass, never freshened into green. A few trees are scattered here and there, which serve as fuel or to make the huts of the Indians. Only a single plant can be cultivated with any success, a plant with a tuberous root, possibly a species of *Tropæolum*. Barley does not ripen, though planted and cut for fodder.

The animal life is comparatively abundant. Here lives the mountain camel, the llama, with its congeners the alpaca and vicuna. Several species of deer, the chinchilla, a species of fox, the cougar, and a black bear frequent portions of this desert tract. Among the birds the condor is the best known, and this bird, with a stretch of wing of from twelve to thirteen feet, soars high above the loftiest peaks and builds its nest in the most inaccessible parts of the Andes. For a long time extravagant stories were told of it. It was the roc of Sindbad. It was invulnerable to a musket ball. It carried off sheep and calves and even young children to feed its voracious young. These are but fables. It lives nearly altogether upon carrion, only attacking live animals when impelled by hunger. It can carry in its claws and beak a weight of from eight to ten pounds, and being very fierce has been known, when in captivity, to attack a child and so injure it about the head as to cause its death.

Another desert region in Peru stretches along the shore of the Pacific for a distance of twelve hundred miles, varying in width from eight to fifty miles. Chains of small hillocks extend westward from the mountains, gradually decreasing in height toward the sea, or ending in abrupt cliffs. A number of small rivers find their way from the mountains to the sea, irrigating patches of ground. Where the influence of these streams is not felt, a fine light yellow sand covers hill and dale. Strong winds raise great clouds of dust. These sometimes form pillars eighty and one hundred feet high, moving most capriciously and with great rapidity over the plain. The sand hills raised by the wind are often without any firm base, and so rapidly is the aspect of the surface changed, that what was one day a plain covered with conical hills is the next a level expanse without any considerable elevations.

The summer commences in November. The rays of the sun, reflected back from each individual quartz grain, exert a blinding, scorching influence. Men double up like hedgehogs to escape the glare. No plant takes root, no animal finds food upon the arid surface. No bird, no insect is to be seen, and only in the very loftiest regions the condor floats on daring wing. Only where ocean and desert meet is any other life to be found. Carrion crows feed on the dead marine animals; seals enliven the rocks, crabs burrow in the sand, and certain coast birds find food in the fish and mollusks of the shore.

The scene changes in May. Then a thin veil of mist overspreads the shore. It gradually increases in density, is heaviest in August and September, and disappears in October. This is the winter season. In May and in October the mist rises from 9 to 10 A. M. and disappears at 3 P. M. During August and September it lies for weeks at the surface, never forming rain proper, but only a thick fog or drizzle. The natives call it the *garua*. The average height to which it extends is about one thousand feet. It is known only within a few miles of the shore, and beyond here it is superseded by heavy rain. The boundary between the region of mist and the region of rain is so well defined that on two adjoining plantations one half is watered by rain and the other half by the *garua;* the boundary line is marked by a wall! When the mists set in, the hillocks undergo a magical change. Vegetation overspreads the soil; horses and cattle for several months find abundant pasturage. Though there is no water, cattle do not seem to suffer from lack of it, for they are always in good condition. This desert has of late years been partially subdued by man, and now a railroad crosses it from the coast, penetrates the mountains, and terminates at Lake Titicaca, 13,000 feet above the sea.

Across the Atlantic, on the African continent begins a series of deserts which extend with little interruption to the boundaries of China. The first of these is the greatest desert in the world, known under the name of *Sahara* or *Zahara*. The Arabian geographers were the first to apply the name. These writers also called it *Sahara-belama*, or the "waterless waste," or *Sahara-ul-aski*, the "complete waste." Beginning at the Atlantic Ocean, this desert extends eastward for a distance of 3,100 miles, broken only by the oases formed by the Nile, and reaching to the Red Sea. The average width is six hundred miles, so that it is equal in area to two-thirds of Europe. It has but one season, that of summer, burning and merciless. While the mean altitude is estimated at two thousand feet, there is one part near the northern boundary one hundred and sixty-five feet below the level of the Mediterranean, and other places on the south and east where the ground rises into plateaux and mountains of sandstone and granite reaching an elevation of six thousand feet and more. In the center stands the mountain Djebel-Hoggar, the top of which is covered with snow three months of the year, while from December to March its sides are furrowed by streams which flow some distance and are lost in the sand. This group of mountains forms the dividing line between the eastern desert, or Sahara proper, and the western portion, known as the Sahel. "The Sahel," says Reclus, "is very sandy. Throughout the greater part of its extent the soil is composed of gravel and large-grained sand, which does not give way even under the foot of the camel." Sometimes it forms hills heavy enough to resist the action of the wind, but in other cases it is so fine and small that the constantly blowing trade winds carry it in clouds to the southwest, encroaching upon the channels of the Niger and Senegal and driving them from their courses. At the west it also encroaches upon the ocean, forming such extensive banks that the Arabs who go to collect the waifs and strays from wrecked vessels can safely venture out several miles from shore. It is also stated that at times the sand so fills the air several miles out at sea that the weather seems hazy. Parts of the desert on the east are sandy also, but the main portion is occupied by plateaux of rock or clay, or groups of mountains.

Scattered in long lines over the desert are numbers of oases, little tracts of land watered by springs of water which gush out of the ground or descend from some group of mountains. Here date palms, apricots, peaches, and other fruits ripen, and caravans stop for rest and refreshment. Every speck of space is utilized, the huts being built on the most unproductive spots. Date palms supply the greater part of the food of men, camels, horses, and dogs.

Immense tracts exist where these oases are not found. Here the path taken by the caravan follows a straight line to its destination. Sometimes the faint footmarks are covered with sand, and then the compass, an occasional hill, a bush, and often a heap of bones indicates the way. Vegetation is rare. Those plants that exist at all are spiny or aromatic. Wormwood, thistles, and the thorny mimosa are the principal kinds. Ants, scorpions, lizards, and vipers constitute the animal life. Flies accompany the caravan for a few days, but are soon killed by the heat, and even the flea finds it impossible to exist. Radiation from the white or red sand dazzles the eye, and all nature looks somber. The mirage displays cities, palaces, groves of palms, lakes and streams of water with a vividness scarcely to be credited. When the wind blows, the face and body are beaten by grains of sand which prick like needles. The wells scattered over the desert are sometimes good, sometimes bad, generally the latter. Sometimes the wells fail or are missed by the guides, and then each drop of water is guarded as a jewel of untold price.

Although terrible stories are told of whole caravans and whole armies being overwhelmed by the sand, and though the bleaching bones of men and camels often line the track of caravans for miles, generally speaking companies led by experienced guides, and protected by treaties from the depredations of tribes through whose country they pass, arrive safely at their journey's end. They experience little suffering except that caused by the bad water, the excessive heat of the day and the cold of night. The air being so entirely destitute of aqueous vapor causes excessive radiation from the soil as soon as night sets in, so that burning days are followed by cold nights. Not a year passes without ice forming on the ground, and white frosts are frequent. A difference of 129° F. has been observed between the lowest (24° F.) and the highest (153° F.) temperature, and the real difference between extremes of heat and cold is estimated at 144° F. Bayard Taylor says that he found he absorbed so much heat during a long day's ride in the desert that, as evening came on, the temperature of his skin commenced to rise, until at night his body glowed like a hot coal.

The eastern portion of the desert, known to the Arabs as the *Atmoor*, is the ideal desert. "This," says General Colston, "consists mainly of hard gravel plains, diversified by zones of deep sand, rocky ridges, sometimes of considerable altitude, and rugged defiles. It is absolutely destitute of all vegetation, and consequently of animal life. Only the ostrich and hyena cross it swiftly by night, and the vulture hovers over the caravans by day. Not a tree, not a bush, not a blade of grass, relieves the glare of the sunlight upon the yellow sand." "Within the limits of Egypt and the Soudan these desolate atmoors extend over three-quarters of a million of square miles, never trodden by the foot of man. Only a few caravan trails cross them in their narrowest part, with scanty wells at long intervals, and the necessities of trade can alone account for their being penetrated at all. They are like oceans, where caravans pass each other in haste, like vessels at sea. The marches are perfectly terrible, and yet it is worse to halt during the day than to keep in motion, for the heat makes sleep or rest impossible even under canvas. . . . The air that blows feels as if it had just passed through a furnace or a brick kiln. Over the plain it quivers visibly in the sun, as if rising from a red hot stove, while the mirage mocks your senses with the most life-like images of lakes, ponds, and rippling waters."

Like the llama in Peru, the camel is the beast of burden of the Sahara. Without this animal these wastes would be impassable. He seems to be formed for this home, and thrives better here than anywhere else. His foot is broad, soft, and flat, enabling him to travel over soft, deep sand where the horse would soon sink down exhausted. He lives on almost nothing, the scanty desert herbs and the thorny mimosa being his favorite food. These, together with the inestimable quality of being able to travel for several days without water, make him the most valuable beast of burden in the world.

The Nile valley may be considered as nothing else than a long oasis in the midst of the desert. The life of this oasis is the Nile, which after centuries of speculation and exploration has had its secret wrested from it. For a distance of seventeen hundred miles above the delta, the river receives no tributaries. At this point two streams, the White and the Blue Nile, join to form the main stream. The latter of the two has many branches having their sources in the mountain regions of Abyssinia. The heavy summer rainfall causes torrents to rush down the sides of hills and mountains, carrying great quantities of soil with them. The White Nile, on the other hand, has its source in the great Victoria Nyanza, lying under the equator. The arable land of Egypt covers an area of about ten thousand square miles, which is made to support seven or eight million people. Where the irrigating waters cease the desert begins, and its limit is as sharply marked as a gravel walk across a greensward.

From the eastern side of the Nile the desert extends without interruption to the shores of the Red Sea, and across this begins the great *Arabian Desert*, a tract not well defined, and but little known. The whole of Arabia has been referred to as a desert and as the abode of the blest alternately; as a land of sand and rock, and a land of spice and incense. In parts of the peninsula both descriptions will apply, for while the whole of the coast is lined with mountain ranges of greater or less elevation, and while on the inside there is everywhere a strip of desert, the central portion of the country is a high plateau, with mountains averaging five thousand feet in height, having numerous springs which make fertile valleys. Roughly, the central plateau constitutes one-third of the area of the peninsula, the desert another third, and the coast ranges the rest. The great desert region is at the south, a sandy waste covering about fifty thousand square miles, only dotted here and there with a few stunted bushes or dwarf palms. Its surface is ribbed by huge waves of sand having a general north and south direction, though the prevailing wind is from the east. But these main waves are again crossed and intersected by others, less regular, produced by variable winds. Sand columns, such as overwhelm caravans in the Sahara, are here unknown. Heat, hunger, and especially thirst, the traveler must contend with. The first is fearful both by night and by day. Some parts of the tract have never been crossed by either Bedouin or Frank. On the north and east are smaller but still formidable deserts. In places the sand is said to be four hundred or five hundred feet deep. In the north, as in the south, are long parallel ridges of sand, like waves of the sea. They have been accounted for by the rotation of the earth, the sand being carried forward particle by particle, while the solid rocks beneath are immovable.

The author of "Eothen," traveling from Jerusalem to Suez, says of the northern part of the desert: "As long as you are journeying in the interior of the desert, you have no particular point to make for as your resting place. The endless sands yield nothing but small, stunted shrubs; even these fail after the first two or three days, and from that time you pass through valleys dug out by the last week's storm, and the hills and the valleys are sand, sand, sand, still sand, and only sand and sand again."

One of the characteristics of the Arabian and other Asiatic deserts is the simoon. This is a violent wind, described by Palgrave as "a peculiar condition of the atmosphere, resembling in all essential points a cyclone. As in the cyclone, the central space, or the simoon itself, is calm, but is occupied by a gas unfit for respiration; while around this as a center, slowly traveling on, there eddy violent gusts of heated air, like those of a furnace, though it is not to them, but to the comparative vacuum which they surround, that the simoon owes its suffocating qualities. It approaches slowly amid the whirl of air currents which precede it for some distance. Its violet color announces it when actually near. During its presence the only chance of preserving life till the mephitic vapor has passed over is found in covering the face with a cloth and lying prone on the sand, thus to inhale what little atmospheric air still exists in the upper ground stratum." The passage of the column lasts from two to ten minutes. The feeling in the chest is like suffocation, and the limbs feel as if molten iron were being poured over them.

A very large part of Persia to the north of Arabia, and the country to the south and east of the Caspian Sea, is occupied by another desert tract. Vegetation about here is said to be so rare that one may travel three hundred miles and see but a single tree. This one specimen is so revered by the wandering natives that they often go far out of their way to hang rags as offerings upon its branches. In Persia the *kavir* or salt desert often extends for a hundred miles in length and stretches out for twenty-five or thirty miles on either side. Sometimes the ground is in ridges, looking as if it had been plowed, left fallow for some time, and then glazed with a coating of salt clay. Riding over this a continual crackling is heard, caused by the horses' hoofs breaking through the glazed surface. "Again the whole surface seems rotten, and the horses' feet sink deeply into it, causing the salt to show white on the surface. Sometimes the solid earth gives place to sand dunes, the road leading up one and down another, and with the soil so loose that the horses sink to their fetlocks or even to their knees."

The region about the Caspian Sea is an arid one, with but few charms to attract, and as one travels eastward the country becomes gradually worse until the Sahara of Asia, the *Desert of Gobi*, is reached. This immense tract of land extends over eighteen hundred miles from west to east and has an average width of five hundred miles. It is a high plateau, with an elevation of about five thousand feet above the sea, and lies between two high ranges of mountains, the Himalaya and the Altai. It is a waste of sand and rock, mostly incapable of cultivation or even of supporting vegetation. The oases are few in number, and contain only a small amount of grassy vegetation, and in a distance of four or five hundred miles there are only five trees known. A few agricultural operations are carried on along its borders during the three months of the year which constitute the summer. During the rest of the year the weather is cold. Swept by icy winds from Siberia on the north, it freezes nearly every night and often during the day. The mercury often sinks to 30° or 40° below zero, and sudden changes are frequent.

The general aspect of the desert is described as extremely desolate. Abbe Huc is one of the few who have penetrated into the inhospitable region, and from him we may glean a general idea of its aspect. "Whichever way you turn," says he, "you find nothing but rocky ravines, hills of mud, and plains encumbered with fine movable sand, which the wind sweeps about in all directions. The only pasturage consists in a few thorny shrubs and thin heaths of a fetid odor. Here and there you find a little thin, brittle grass, which sticks so closely to the ground that the animals cannot browse it without scraping up the sand at the same time."

Immediately to the north of the mountains inclosing the Thibetan plateau the desert assumes its most terrible aspect, "being covered," says Williams (Middle Kingdom), "with dazzling stones and rendered insufferably hot by the reflection of the sun's rays from these and numerous movable mountains of sand. Nor is the climate more endurable in winter. The icy winds of Siberia, the almost constantly unclouded sky, the bare saline soil, and its great altitude above the sea, combine to make Gobi one of the coldest countries of Asia." A Chinese author has well expressed its desolation, for he says, "There is neither water, herb, man, nor smoke; and if there is no smoke, there is absolutely nothing."

The great Yellow River is the dividing line between the desert and the fertile provinces of China. On the western side of the river is a range of mountains, and in the ravines are heaps of mica and stones, broken and often pulverized. The rocks are incrusted with shells and *debris* resembling sea weeds, and are cut and worn into holes in all directions, as if they had been subjected to the action of gigantic worms. This peculiar condition of the rocks is probably due to the action of sand blown by the winds from off the desert.

Bordering one side of the desert are the Alechan Mountains, described as being formed of sand so fine that it will run through the fingers like water. Here there is absolutely no trace of vegetation. Insects ornament the surface with their tracks, for even that made by an ant may be perceived. The yellowish color of the Yellow River, or Hoang-Ho, is due to the sand forming these mountains, for above them the waters are pure and limpid.

Passing, in imagination, across the Malay Archipelago and the Indian Ocean, turn and take a glance at the desert region of Australia, of a size nearly equal to the whole of Europe. This vast island contains tracts of desert which rival Gobi or the Sahara in their desolation. In proportion to their extent they have been the most difficult of all to explore. The few daring travelers who have crossed these deserts in safety draw pictures of horror. One party traveled for seventeen days, covering three hundred and thirty-seven miles, without finding a drop of water. A shower of rain then fortunately fell, and the party were saved. A second time seventeen days passed without water being found, when a water hole was discovered, which proved their salvation. Danger from natives is added to danger from heat and from thirst. Vegetation is confined to spiny shrubs, a few trees, and dry grass.

In a few words, as stated by one of the explorers, the center of Australia contains "half a million square miles (about one-fifth of the entire area of the continent) which offer nothing but barrenness and death to the bold invaders. The southern part of this wilderness is dotted with hills of soft, white, yielding sand, thickly clad with spirifex, scrub oak, and other low shrubs, and an occasional group of eucalyptus. The northern portion of this desert is almost entirely destitute of even this useless vegetation, and its sands hills have not even spirifex to relieve their arid glare. Frequently the intense rays of the sun in summer set the parched foliage of the wilderness in a blaze, and devastating fires prevail, giving rise to hot winds, which make their presence felt in the outlying settlements." All our knowledge of this desert tract has been obtained in the wild race for life of travelers across it. It is possible that in the future grass may grow and sheep may browse where now sand and sun contend for mastery.

Leaving now the old world, with its circle of desert tracts, we cross the Pacific Ocean and enter our own country to view in a short space the Great American Desert. This is, it is true, a term of very vague application, and must be restricted to a smaller area than that to which it was originally applied. Consult any of the earlier maps of our Western country, and large areas will be found marked deserts where now are prosperous farming communities or extensive cattle ranges. Nevertheless the term may be aptly applied to large portions of Nevada, Utah, Arizona, New Mexico, and Southern California. The Colorado and the Mojave deserts in the latter State, though deserts in every sense of the word, are limited in area, and must give place to the larger desert which occupies the other four States or Territories. Government explorations have made this part of the world familiar to us, and it is in one of those usually dry-as-dust reports that we find a most vivid picture of the Great American Desert. Eliot Lord, in his report upon the Comstock Lode, says:

"The cloud banks blown overland from the Pacific are thrown in masses against the bristling teeth of the Sierra Nevada. Repelled at every point, they break in rain, snow, and hail among the mountains. Winter storms tear their way sometimes through this unyielding barrier and bury the hill tops beyond under eddying snowdrifts, but a covering is rarely cast over the deformity of the deserts below. Looking eastward from any bare crag above the tree belt, the eye sees no end to these desolate wastes, and beyond the range of vision they stretch unbroken for hundreds of miles. A few shallow rivers, fed by the mountain snows, wander in narrow beds through the canons and valleys, vanishing at length in alkaline sloughs or pouring their wasted streams into brackish lakes. Broken fringes of green mark their winding courses—the only relief to the somber tints of the landscape."

Viewed from a distance, the repulsive features are softened in tone. A velvety brown appears to cover the rocks and hills: white clay banks gleam like silver. Over all is a sky of the clearest blue, flushed with the splendor of noon or glittering coldly with stars.

"Descend into the midst of the desert and look closely around. The soft brown slopes are changed to scarred and naked rocks, the shining lakes to beds of alkaline earth seamed with innumerable cracks, and the gray plains to wastes of sand dotted with clumps of sage brush. Here and there at long intervals stalks of bunch grass thrust their stiff blades out of the arid soil, covered often with clinging crystals of salt which sparkle like frost in the sunlight. Dusky lizards dart about among the blackened rocks of the isolated ridges, and lizards with yellow backs sprawl on the hot sand. A little flock of sparrows may hover about some mountain spring, a coyote sometimes ambles over the hills, and jack rabbits scurry through the sage brush in ridiculous alarm, but the oppressive stillness is rarely broken by the movement of anything with life. Nature seems to sleep, except when the brooding air is stirred by the passage of clouds and columns of feathery dust, borne by eddying whirlwinds over the desert." "It was over this dreary land that the Mexican guide of Fremont pointed, from the mountain pass at the head of the river San Joaquin. 'There,' said he, 'there are the great llanos. There is neither water nor grass—every animal which goes out upon them dies.'"

This description applies to many hundreds of square miles of our Western territory. The great basin region is one of rock, sand, and alkali, with a scanty growth of sage brush and a little animal life. It is crossed by numerous railroads, is the seat of great silver mines, and the grave of hundreds of luckless emigrants. For in the days of gold excitement in California, many a wagon was abandoned, many an animal lay down to die, many an emigrant perished of hunger, or of thirst, in the Humboldt Desert.

Having now passed in review the main desert regions of the earth, let us devote some little space to the question of the origin of the deserts. For some the answer is simple. Meteorological conditions have had much to do with them. The Puna and the coast desert of Peru can be ascribed to the presence of the Andes and to the direction of the prevailing winds. The rainy winds of the northern half of the continent of South America come from the Atlantic. Laden with moisture, they strike against the high peaks of the Andes, and they are forced to ascend. Here the vapor becomes condensed into clouds, which break as rain and deluge the eastern slope of the mountains. Crossing to the other side, they descend as dry winds, and continue their course to the westward. At the southern end of the continent, on the contrary, the rains come from the Pacific. Here the moisture-laden winds strike the Andes, drop their rain on the western slope, and travel eastward over Patagonia as dry winds.

The desert of Gobi, in Asia, owes its existence to a similar cause. In this case the Indian Ocean supplies the moisture, which is all wrung out by the Himalayas, so that the winds descend to the north as dry ones. So, too, is it with the deserts of Utah and Nevada. Here the winds come from the Pacific, and, being robbed of their burden by two successive ranges of mountains, reach the interior as thoroughly dry winds. The case is different with the Sahara. This is in all probability an ancient sea bottom, gradually elevated by volcanic agency. It was thus naturally arid. The westerly winds from the Atlantic lose all their moisture by the hot air from the desert, or else are driven up to the higher regions of the atmosphere. If a high range of mountains, sufficient to stop and condense the moisture from the western winds, was on the eastern side of the desert, its aspect would probably be vastly different from what it is.

The area about the Caspian is also probably the bed of an extensive mediterranean sea. Dr. Carpenter gives many reasons for supposing that at one time the present Caspian was connected with the Arctic Ocean on the one hand and with the Black Sea on the other. A slight elevation of land at the north would cut off its connection with the Arctic; while an increased evaporation, or decreased rainfall, would cause connection with the Black Sea to cease. Then, of course, greater evaporation would cause further contraction and consequent exposure of much land with quantities of salts of various kinds. The Arabian deserts have been stated to be due to the disintegration of chains of mountains, but too little is known of the country to speak with any certainty. The same may be said of the Australian deserts; their cause is not known. Probably they represent, like the Sahara and Gobi, the bed of an ancient sea.

The small, comparatively speaking, Colorado desert in Southern California was probably the ancient head of the Gulf of California. The head was one hundred and seventy miles further north than its extreme northern extension now. The proof of this is to be found in the vast quantities of dead shells scattered over the desert; in the extreme fineness of the soil; in the extent of its depression below sea level, some two hundred and sixty feet; in the evidence of a shore line

found along the mountains bordering it on either side; and finally, in the traditions of the natives, which refer to the presence of a "great water" in which their fathers fished, and upon whose shores they dwelt. The ancient shore line can be seen following all the indentations of the shore at a uniform level for many miles, and plainly marked by a calcareous incrustation extending below but not above the line of shore.

The Colorado River carries down an immense amount of sediment into the Gulf of California. At the time of the existence of the ancient bay, the mouth of this river was one hundred and seventy miles from the northern end and at a narrow part. Detritus gradually filled up the gulf opposite the mouth, so that after a time water only entered the northern extension at high tide. Still later it entered only on the occasion of a river flood and a very high tide, and finally the sea was shut out entirely, and no water replaced that lost through evaporation. Then the lake rapidly diminished in extent, until it finally disappeared altogether. Such may be considered the history of this small and in many senses interesting desert of California.

It would be an interesting inquiry to endeavor to determine the effects of the larger deserts upon civilization. For if we are to believe the author of the "Decline and Fall," the inhospitable features of the great Gobian desert are responsible for the hordes of Huns and other tribes which poured in such an incessant stream into Europe from Central Asia. Such may have been the case, and if so, it was fraught with great importance to the welfare of Europe. Stopped by ranges of mountains or by the warlike Chinese on the east, the way to the west lay invitingly open, a gradual slope for hundreds of miles. Thither they marched, and swarmed like locusts over the fair fields of Central Europe. So too, if we are to believe some, we may look even further back into the "dim corridors of time" and discern the primitive Aryan race, the early ancestors of earth's dominant family, coming into view. They also found toward the west their easiest path, and taking the setting sun as their guide, were first to show that

"Westward the course of empire takes its way."

OTTO PATENT WIRE ROPEWAY.

IT is somewhat surprising that so little progress has been made of late years, in this country, in the design and adoption of aerial tramways, the old Hodgson system of single endless running rope, to which the buckets are attached and carried along, being the only one so far employed. These single rope tramways are, from the nature of their construction, limited to the carrying of light loads, and subject to considerable wear and tear; this may partly account for their not having been more extensively adopted.

With the Otto ropeway these drawbacks have been overcome by using fixed ropes, of considerable diameter, to carry the load, and a light flexible endless steel wire rope for hauling it. This plan enables these lines to be carried over wide valleys and rivers and up very steep inclines without difficulty, and permits of an economical transport of large quantities of material. Nearly 300 of these ropeways are now at work, so that there is no longer any question as to their practical utility and efficiency. Single lines on this principle are at work, varying from 100 yards to several miles in length, and spans of over 1,000 ft., with a carrying capacity of 5,000 tons per week, and two to three times this amount on lines arranged with double and triple systems of fixed ropes.

Messrs. Commans & Co., mining engineers, of London, recognizing the great importance of this cheap means of transport, have taken up the manufacture of the Otto ropeway for this country and the colonies. So far, the only section of line they have erected in this country has been the one they exhibited at the late Newcastle-on-Tyne exhibition, and for which they were awarded a silver medal—the highest award given—by the haulage committee. This system of transport, we are convinced, has only to become better known to

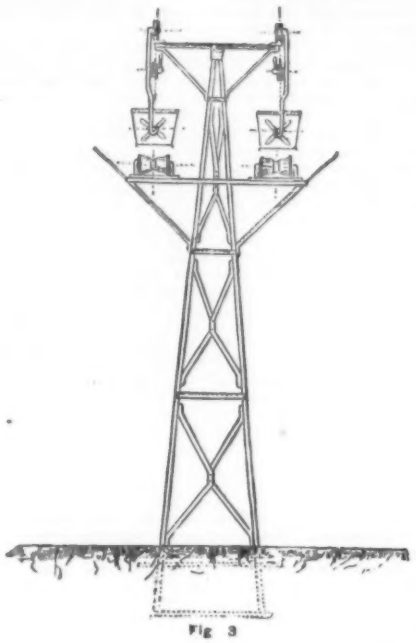


Fig 3

be very generally adopted, not only for the transport of mineral, but also for all kinds of goods overland, where the construction of ordinary tramways would be either too costly or impossible. This same system of transport has also lately been largely employed in factories, breweries, etc., for carrying the goods about in the buildings and warehouses, fixed hanging rails being employed in the place of the wire ropes.

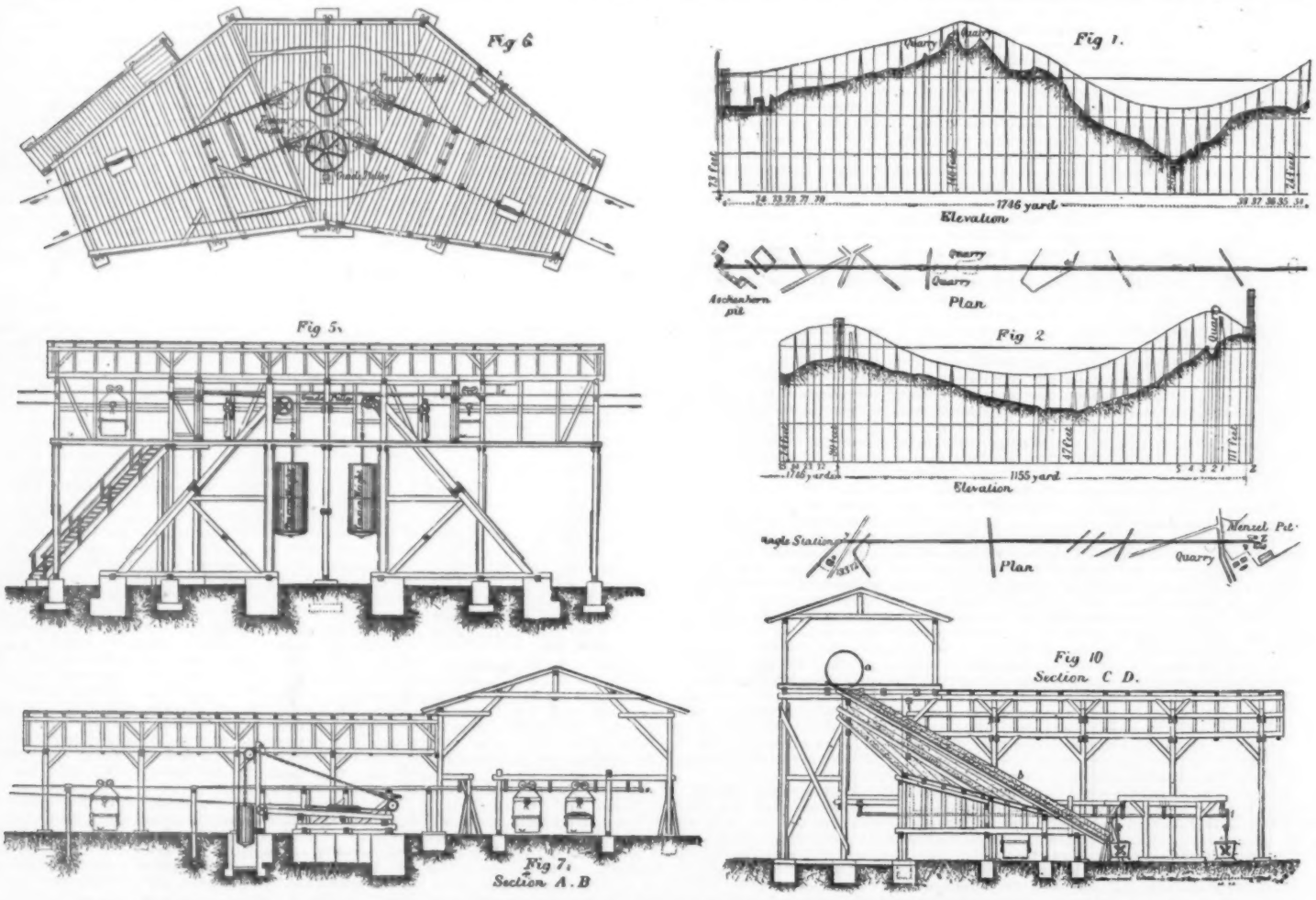
In order to give a more clear idea of the capacity and efficiency of these ropeways, we will fully describe an existing line, and have chosen for this purpose one at work at the Gottesegen Colliery, near Antonienhutte, in Upper Silesia. The Gottesegen Colliery, together with the Hugozwang Mine, some mile and three-quarters distant, belong to Count Hugo Henckel von Donnersmarck. The main shaft of the Gottesegen Mine is known as the Aschenborn, that of the Hugozwang as the Menzel shaft. These two shafts communicate with each other by a gallery some 500 ft. below the surface; but above ground, before the ropeway was built, there was no direct communication. The shafts are joined up to the main Silesian railway system at Morgenroth station by two short branch lines, some four miles in length. The line from the Menzel shaft to Morgenroth station is, however, of a narrower gauge than the main line, so that all the coal from this colliery required to be unloaded into main line trucks, which entailed considerable expense and increased the amount of small coal.

At the Aschenborn Colliery there is a very complete

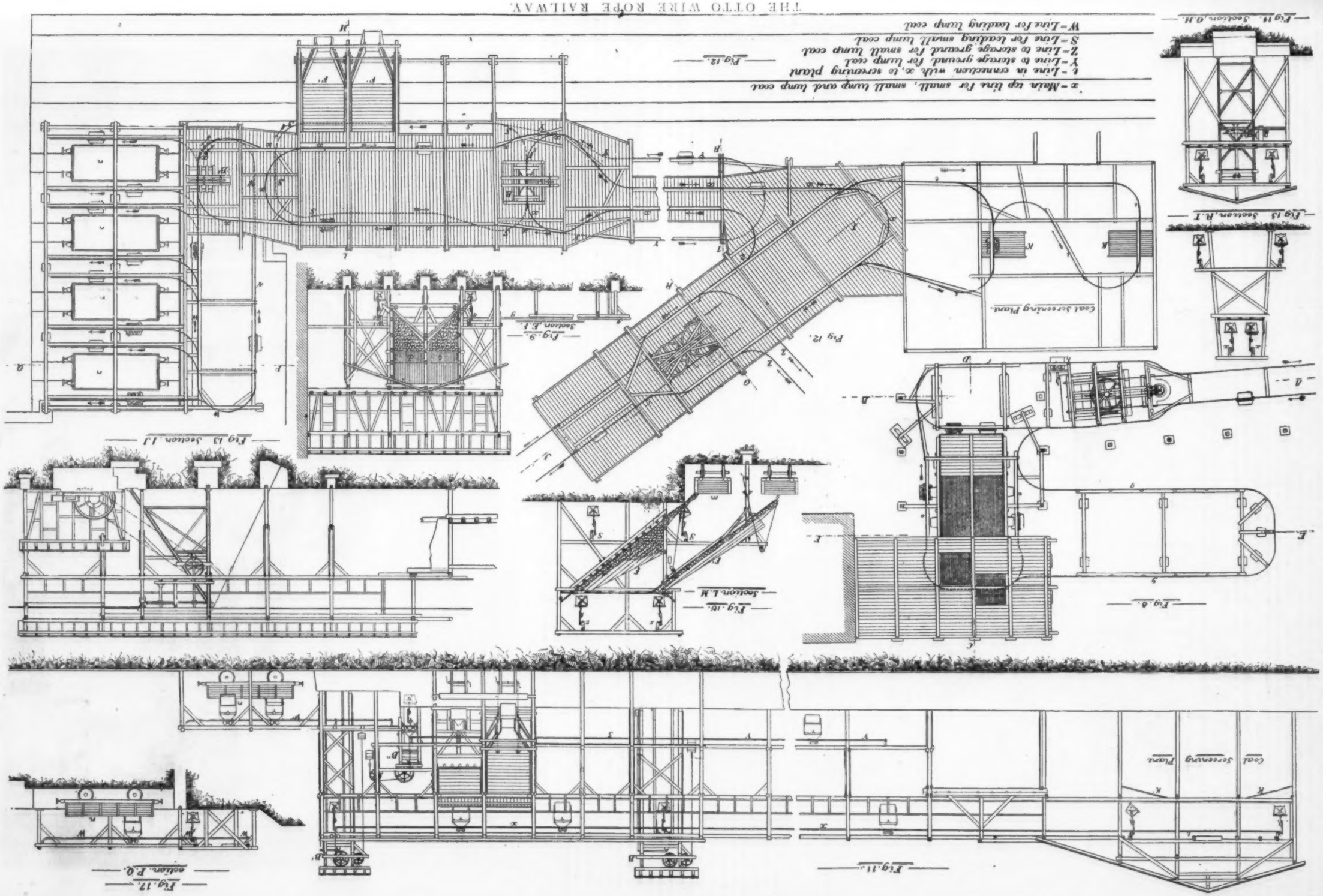
Fig 4

modern screening plant, capable of treating some 700 tons to 800 tons per day; but the arrangements for screening at the Menzel shaft are somewhat primitive. In order to reduce the cost of transport and loss through breakage of coal from the Menzel shaft, to employ this coal when necessary at the Antonien Ironworks, and to make use of the above mentioned screening plant at the Aschenborn shaft, it was deemed necessary to make some alteration in the means of communication between the two pits. Several schemes were taken into consideration; but, after weighing the advantages of both underground and overground haulage, and careful calculation of the cost, the Otto system of aerial ropeway was finally decided upon as being the cheapest and most suitable.

The line was erected during a very severe winter, and took about six months to erect. Ever since its completion it has been at work without the least in-



OTTO WIRE ROPE RAILWAY, GOTTESEGEN COLLIERY, ANTONIENHUTTE, WESTPHALIA.


x—Main up line for small, small lump and lump coal.
t—Line in connection with x, to screening plant
Y—Line to storage ground for lump coal
Z—Line to storage ground for small lump coal
S—Line for loading small lump coal
W—Line for loading lump coal
Fig. 12.
Fig. 14. Section, G H.
Fig 13 Section, R I
Coal Screening Plant.
Fig 12.
Fig. 9. Section, E F.
Fig 13 Section, I J
Fig. 10. Section, L M
Fig. 6
Fig. 17. Section, P Q.
Fig. 11.
Coal Screening Plant.

terruption, and has effected a great saving in the cost of transport, and has thus fully proved that the choice of an aerial ropeway was the right one. As it was found if the line was made straight, from shaft to shaft, it would have to cross over other people's property, it was therefore decided to insert an angle station, which slightly increased the original cost.

Description.—As will be seen from the plan and sectional elevation, Figs. 1 and 2, the ropeway consists of two straight lines at an angle of 133° 12'. The length of the line from the Menzel shaft to the angle station is 1,155 yards; from the angle station to the discharging station at the Aschenborn shaft, 1,746 yards; thus giving a total length of line of 2,901 yards—1·6 miles. The greatest incline on the line is where it crosses the main road after leaving the Menzel shaft, and is 1 in 11·8. The fixed carrying rope for the full buckets is 1⅜ in. diameter and for the empty buckets 1⅛ in. diameter. These ropes are of steel and of special construction, which from experience has been found most suitable for this class of work; the breaking strain of the larger being some 43 tons per square inch, and of the smaller some 28 tons per square inch. The fixed ropes are supported on wrought iron standards at an average distance of about 38 yards apart, the design of which is clearly shown in Figs. 3 and 4.

At the end stations the ropes are firmly anchored in masonry, the tension weights for keeping the ropes taut being fixed at the angle station, as shown in Figs. 5 and 6. The weights for the loaded and unloaded ropes are respectively 7½ tons and 4⅛ tons, or only about one-sixth of the breaking strain given above. The driving rope is ⅝ in. diameter, of crucible steel, having a breaking strain of 11½ tons per square inch. At the angle station the hauling rope runs over two horizontal guide pulleys, as shown in Figs. 5 and 6. The rope is driven by a horizontal engine situated at the unloading station, Fig. 13, having a cylinder of 11¾ in. diameter and 23⅝ in. stroke. The power is transmitted by belt and bevel gearing to two large grooved pulleys lined with leather, 7 ft. 3 in. diameter, around which the hauling rope is several times coiled. The arrangements for adjusting and tightening the hauling rope consist in a horizontal pulley attached to a movable frame working in guides, which is constantly loaded with a weight, as shown in Figs. 7 and 8. The weight is about 1½ tons, so that the strain on the rope would be about ¾ ton. The maximum strain on the rope when driving the full complement of buckets is about one ton.

The carriers, Fig. 18, consist mainly of four parts; the bucket or skip, the truck or runner, the triangular frame or hanger connecting the two, and the grip or clutch for laying hold of the hauling rope. The buckets in this instance are made of steel boiler plate and have a capacity of 22 cubic feet, or about 10 cwt. of coal. The truck, Figs. 19 and 20, consists mainly of a frame and two grooved wheels. The frame is composed of two steel plates held apart by a cast iron distance piece in the center and two distance pieces at the ends, which also form the spindles for the grooved wheels and are hollowed out to hold grease or other lubricant, which can be inserted by removing the screwed plug at the ends of the same. By this simple arrangement of supporting the spindle at both ends the grooved wheels can never get atwist, thereby effecting a great saving in the wear and tear of the spindles and wheel bosses. The hanger for carrying the bucket is supported by a spindle passing through the center distance piece, and hangs on one side of the truck. The grip employed in this instance is Otto's patent disk or friction arrangement, Figs. 21 and 22, which for gradients under one in six has given excellent results. It is attached to the channel iron cross bar, *s*, of the triangular hanger framing; by means of the disk, *a*, the second disk, *b*, is free to move on the spindle, *c*, and when the buckets are standing still acts as a guide and support to the hauling rope, *g*. This spindle, *c*, is firmly bolted to the disk, *a*, and has a square-threaded screw, *d*, on its outer end, with a nut connected to the lever, *e*. If the lever is hanging down, the disks do not grip the rope, and are kept apart by means of the spring, *f*; on raising the lever through an angle of 180 deg. the disks approach each other, and the hauling rope is tightly gripped between the same.

The trigger, *l k*, dropping into a notch in the spindle, *c*, prevents the lever falling in transit. The disks can be adjusted to suit the size of rope by means of the locknuts, *n*. On the carrier approaching a station the trigger, *l k*, and lever, *e*, come in contact with the fixed plate, *m*, attached to the station. The lever, *e*, in falling to a vertical position, separates the disks and releases the grip and automatically frees the carrier from the hauling rope. The carrier, by virtue of the momentum, moves up a tongued rail off the carrying rope, and is at once switched on to a siding of fixed rails, which can be of any desired form or length. A man then moves the carriers along the siding to the point where the skips have to be filled or emptied.

To start the bucket on its journey, and to throw the carrier again in gear with the hauling rope, all that is required is for the man to bring the lever, *e*, up again into the vertical position shown in Fig. 21. At the angle station, Fig. 6, the carriers are thrown in and out of gear in exactly the same manner. The skips, Fig. 24, as they arrive detach themselves automatically from the hauling rope, and are pushed round on the fixed rail by a workman on to the second section, the grip once more being thrown into gear with the second hauling rope.

The speed of the hauling rope is about 3·35 miles per hour, and the buckets are attached at intervals of 126·3 ft., so that one bucket arrives every 25·7 seconds, from which it will be seen the line transports 700 tons of coal per day of ten hours. The loading station at the Menzel colliery—Figs. 7, 8, 9, and 10—is of wood. The trucks as they come from the pit are run on to a tippler, *a*—Fig. 10—and emptied over a screen, *b*, which divides the coal into three sizes. The large lumps pass down the screens direct into the carrier buckets, the small lumps

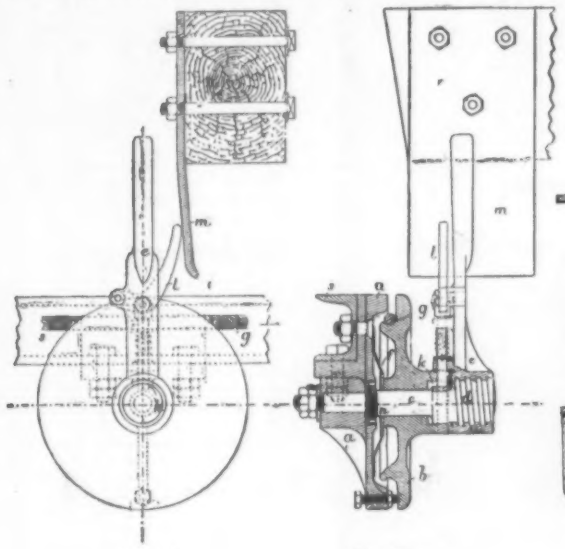


Fig. 21

Fig. 22

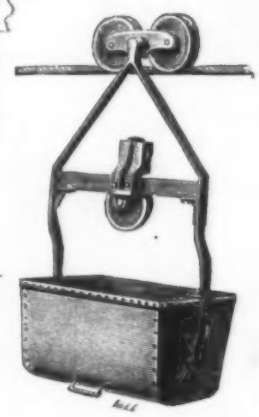


Fig. 24.

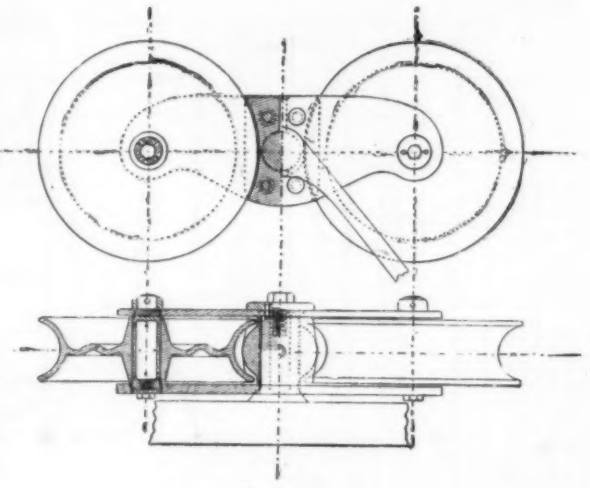
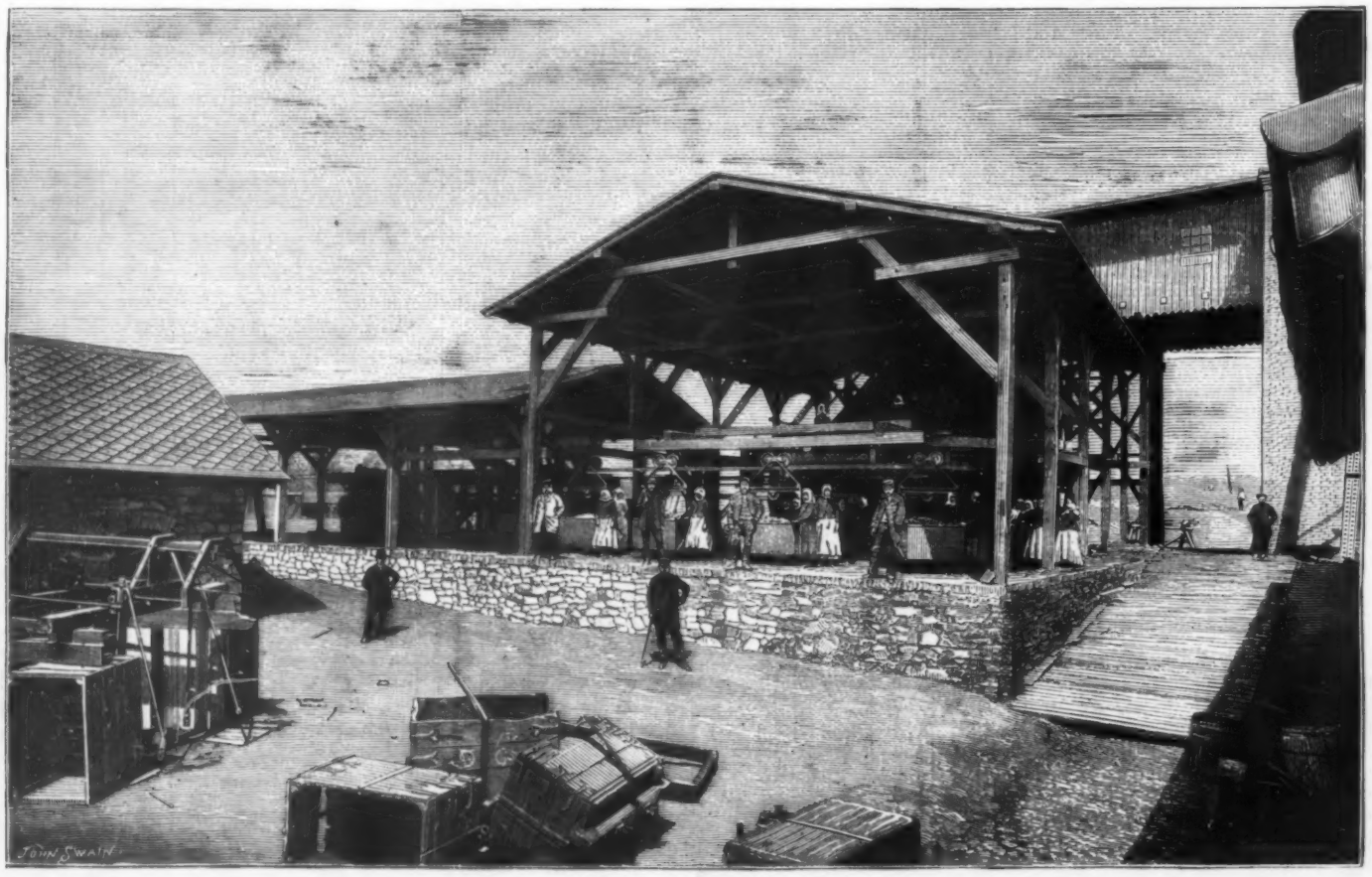


Fig. 23



OTTO WIRE ROPEWAY, GOTTESEGEN COLLIERY, ANTONIENHUTTE—TERMINAL STATION.

and fine coal falling into the two separate hoppers, *c* and *d*—Fig. 9—which discharge through shoots into the buckets. The buckets after being filled are pushed along the fixed rails, *e* and *f*—Fig. 8—on to the carrying rope, and thrown into gear with the hauling rope as described above.

the line, *x*, and run round and tipped over the shoots, F F¹—Figs. 12 and 16. The buckets containing small lump coal are either switched off on line, Z, to the storage ground or on to *x*, and lowered by means of the balanced hoist, B—Fig. 11—which takes two buckets at a time, to the rail, S, where the coal is either

transported at only 500 tons a day, is about 1s. 3d. per ton per mile; or, including repairs, interest on capital, and depreciation, about 1¼d. per ton per mile. For loading and unloading the coal at the stations only twelve to fifteen women are now employed, whereas there were formerly sixty-six; and two

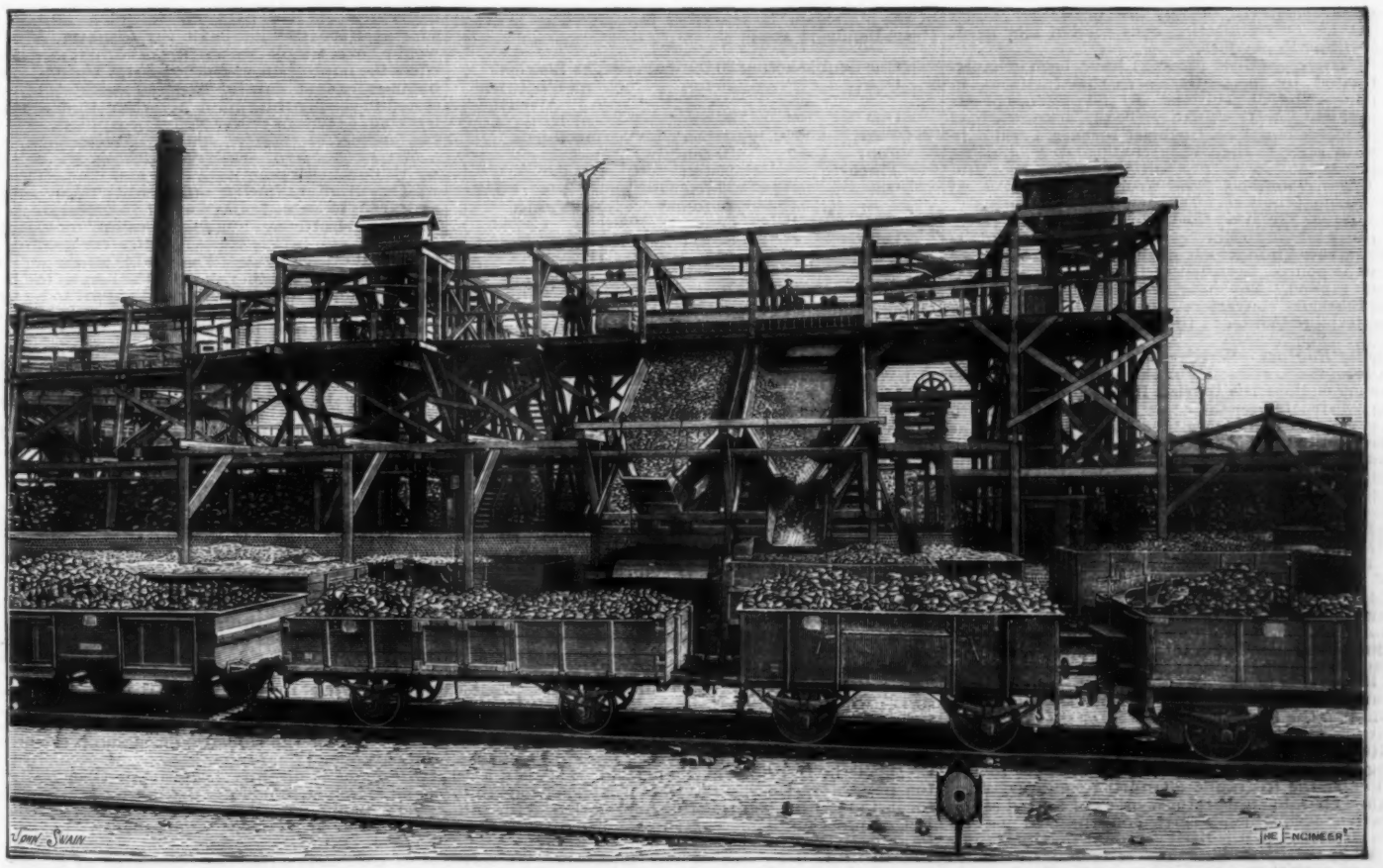
THE OTTO WIRE ROPEWAY, GOTTESEGEN COLLIERY—VIEW IN OPEN COUNTRY.

The weight is registered as they pass over the scale, *h*, by means of an automatic weighing machine; *g* is a shunt line for storing a reserve of empty buckets. On the arrival of the buckets at the unloading station—Figs. 11 to 17—at the Aschenborn end of the line, they can be switched at points 1 and 2—Fig. 12—on to whichever of the branch shunt-lines may be desired. If the small coal is to be further screened and sorted, it is run on to the rails, *l*, and tipped on to the shaking screens, K K¹—Figs. 11 and 12—in the coal screening house, where the various sizes are conveyed on endless bands to the railway trucks. If, on the other hand, it is desired to load the small coal as it arrives at once into the railway trucks, the buckets are switched on to tipped automatically or by hand into the railway wagon, *m*—Fig. 16. The lump coal on its arrival is switched also on to line, *x*, and lowered by means of hoist, B, on to the line, Y, if the same is to be stored; or by lift, B¹—Fig. 11—on to line, W—Fig. 17—if it be desired to load it at once into the railway wagons, *n*—Figs. 12 and 17.

The hoist—B², Fig. 11—is only employed to lower the buckets from the lines, S and Y, on to the line, W, when it is required to load the wagons, *n*, with lump coal from the storage ground. The three stations are connected with electric bells and telephones, and the unloading station is fitted with a counter which records the number of buckets that arrive.

The cost of working this line, taking the quantity

horses less are required for shunting the trucks, so that it has been found that the adoption of the ropeway has given even better results than had been calculated when making out the original estimate, and that a very great saving in expense has been effected. It is difficult to give the exact cost of transport, as this will of course vary with these ropeways according to the quantity transported, price of labor, and the cost of construction of the line. In the case of the ropeway at Esch in Luxemburg, which is three miles in length and transports 300 tons of ore per day of ten hours, the cost of transport, including all expenses, viz., wages, repairs, interest on capital, and depreciation, works out to only 4½d. per ton, or 1½d. per ton per mile.



THE OTTO WIRE ROPEWAY, GOTTESEGEN COLLIERY—DELIVERY AND TURNING STAGES.

These ropeways are now at work in all parts of the world, and one nine miles and three-quarters in length, and capable of transporting 400 tons of ore per day over a country impassable by any other means of transport, has just been opened in the South of Spain to convey the ore from the Serena de Bedar to the sea coast at Garrucha. On this line there are gradients of one in three, and spans up to nearly 1,000 ft. There is no limit to their application. At the smelting works of Rumelange in Belgium, for instance, the iron ore is carried on one of these lines direct from the mines to the top of the three blast furnaces, and works day and night, transporting 2,000 tons of ore per day of twenty hours.

As regards the life of the ropes, this of course greatly depends on the care which is bestowed in looking after them. On a line at Giessen in Germany, carrying daily 350 tons of ore, the same hauling rope has been in use for eight years. As for the carrying ropes, they last from five to ten years, according to the amount of traffic passing over them. One of these ropeways will shortly be erected at the renowned Sheba Gold Mine in the Transvaal, for the transport of the quartz from the mine to the stamp batteries.—*The Engineer.*

SOME OF THE BIG THINGS NOW ACCOMPLISHED BY THE MANUFACTURERS OF IRON AND STEEL.

WE make the following abstracts from the recent presidential address of Sir James Kitson, before the Iron and Steel Institute:

The references to Low Moor recall to my memory an experience of my father, who did business as a locomotive engine builder more than fifty years ago. In one of his early years he required a plate for a firebox which weighed a little over 5 cwt. He was told by the manager at Low Moor that it was so big a plate he would not guarantee to make it, but he would do his best. The plate was made. Now, Mr. Wilson tells me that Charles Cammell & Co. have rolled a plate weighing 65 tons. This personal experience suggested to me that it might not be uninteresting to you to-day, and also it might be valuable as some record hereafter, to make a rapid comparison between the work of the present and that of the period I have referred to, by giving a few examples of the big things which are now accomplished by the manufacturers of iron and steel, and of the tools with which they do their work. The development of the manufacture of steel, and the need of more powerful tools to manipulate steel ingots, called for the skill and services of the engineers, and among the most remarkable efforts of this age must be reckoned the inventions and appliances of the mechanical engineer.

The splendid discoveries of Sir Henry Bessemer, the inventions and processes of Siemens, owe their success to the wonderful tools and appliances which have been designed and constructed as quickly as ever the need for their services has arisen.

In his presidential address in 1873, Sir Lowthian Bell said: "It cannot be otherwise than gratifying to witness the immense advance which has been effected in the power and excellence of the machinery in our forges and mills." But what an advance there has been in the fifteen years which have passed since this observation was made!

In my examination of this subject of the improvement of the appliances of machinery to the manufacture of iron and steel I have found myself embarrassed by so many examples that I am obliged by space and time to restrict myself to a few prominent ones. I do not venture to say I am giving you absolutely the biggest things of their kind, but they will serve to review our progress, which is really stupendous, and justifies us in asserting that there is no visible limit in the capacity of the steel trade to provide for the use of the engineer any material of any size or weight which naval service or engineering construction may need, and be willing to pay for.

Blast Furnaces.—Blast furnaces have been exhaustively treated by the addresses to this Institute, in many papers and descriptions. In the presence of our past president, Sir Lowthian Bell, the acknowledged first living authority on the blast furnace, I will only venture to refer to them as mechanical developments by calling attention to the furnace at Carnegie Brothers' Edgar Thomson Steel Works, in the United States, which produces 2,000 tons of pig iron weekly. At the Edgar Thomson Steel Works there is a novel apparatus which appears worthy of mention. This is a mixer, a vessel into which all the iron from the blast furnaces is poured from ladles into which the metal has been tapped. The metal is drawn out as required for the Bessemer converters. The result is stated to be a material reduction in the percentage of defective rails.

Blowing Engines.—Satisfactory working having resulted from the application of the compound principle to blowing engines, the Dowlais Iron Company are now having constructed for their new furnace at Cardiff engines of this class to blow either 7 lb. or 10 lb. blast as may be required. The engines will be vertical and direct-acting, with the steam cylinders placed above the blowing cylinders. The boiler pressure will be 100 lb. per square inch. The blowing cylinders will be 88 inches diameter and 5 feet stroke; the steam cylinders, 36 inches and 64 inches diameter. The low-pressure cylinder will be jacketed, the condenser will have brass tubes 1 inch diameter outside, with 3,000 square feet of condensing surface. The engines are being constructed by Kitson & Co., Leeds. Cogging mills, reversing rolling mills, shearing machines, hydraulic charging machines, leviathan steam hammers, testing machines, live rollers, hydraulic forge presses, are new mechanical appliances which have been devised to assist in carrying on the manufacture of iron and steel. I am unable from lack of space to name the appliances surrounding the Bessemer converter, or the cranes and contrivances which serve it. Hydraulic pressure has permitted the use of numerous labor-saving appliances. Among the most ingenious and useful of these tools I would name the hydraulic charging apparatus. This hydraulic charging apparatus consists of a fixed center with a long arm, which is carried on wheels at one end and is attached to the fixed center at the other; it is revolved by two hydraulic cylinders and rams, attached to the arm with chains working round the fixed center. The peel is raised or lowered by a hydraulic ram at the end of the arm. By means of this apparatus the same men at the same hammer turn out four times the weight of hammered ingots they formerly produced.

Live Rollers.—Live rollers have been designed which convey the ingots to the cogging and finishing mills, and afford a great economy and facility in the transport of the ingots. The best example of live rollers that I know is that of the Barrow Steel Company. The ingots are transported by live rollers to the cogging mill, and from this point to the receiving bench. The rails travel in one direction only, and are conveyed entirely by mechanical means a distance of 553 feet. The whole design is an admirable example of modern practice in the application of mechanism to the transport of material in the course of manufacture, and reflects the greatest credit on those who suggested and those who engineered the work. This mill could roll 5,000 tons of rails per week if continuously fed with ingots. Live rollers are now also used in plate mills not only to feed the mill, but to traverse the plates from roughing to finishing rolls; and so much is the output thus increased that at the Consett Iron Works, Mr. Jenkins tells me, they have rolled in one turn 105 tons of marketable plates, which is equal to an output of 1,000 tons of plates per week. This make is achieved steadily week by week. Twenty-five years ago it was considered very good work to turn out 250 tons in one week. This plate mill is of the lever-clutch reversing type, having grain and chilled rolls each 8 feet long by 28 inches diameter. The top chill is balanced, as well as the grain, by weights. The plate, after being reduced to a thickness suitable for finishing, is traversed by steam power to the chill rolls, where on the front side is provided a fixed platform, with live rollers as above. The engine has one steam cylinder 45 inches diameter and 5 feet stroke, and flywheel weighing 50 tons.

Improved Shearing Machines.—The 5 cwt. plate I named was sheared in the old crocodile shears, cutting 12 inches long by ¾ inch thick. The latest large shearing machine is one made by Joshua Buckton & Co., Leeds, which cuts a steel plate 2 inches thick, cold, with a blade 10 feet 6 inches long. It will cut a plate 7 feet wide across the middle at one stroke. A machine of similar design is being constructed by Bolckow, Vaughan & Co. to cut 2 inches thick with 9 feet between the standards, and 4 feet 6 inches reach of gaps. A similar machine for cutting blooms 30 inches wide by 11 inches thick cuts regularly 2,000 tons of measured slabs per week at the Consett Works.

Testing Machines.—A machine made by Messrs. Buckton for Her Majesty's dockyard at Malta breaks a cable made of 3¼ inch diameter iron, and tests up to its proof load a cable made of 4½ inch diameter iron. It will admit and test anchors of the largest Admiralty pattern; also it will crush, twist, bend, or shear specimens of steel up to 3 inches diameter. It admits 80 feet long between the shackles, and the hydraulic straining ram has 7 feet stroke.

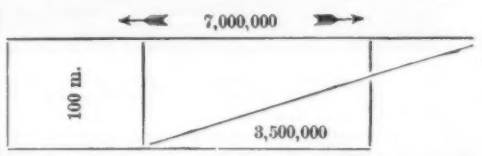
Steam Hammers.—A reference to the steam hammer has a special interest at this moment, as it is a tool which appears to have reached its fullest development. The 100 ton steam hammer at the works of Schneider & Co. has a cylinder which is 1·900 m. diameter, and it has a course of five meters and an anvil block weighing 750 tons. The 50 ton steam hammer of Krupp, Essen, Germany, is the earliest of the big steam hammers of Europe. It was built from the designs of the late Mr. Alfred Krupp in 1861. The falling weight, or tup, weighs 50 tons, and the anvil block weighs 1,100 tons—a proportion of block to tup which is wisely largely in excess of that of the French hammers; the anvil block of the Creusot hammer being 7½ to 1, of the 100 ton hammer of Marrel 5 to 1, and Krupp's block 22 to 1. There are four steam cranes for the service of this hammer, two of 30 tons and two of 60 tons each. I have extracted from a most valuable memoir on steam hammers by A. & S. Casalonga a list of the big steam hammers of Europe. The heaviest steam hammers are:

One double-acting	30-ton	hammer,	at Elswick.
One "	35-ton	"	at Woolwich Arsenal.
One "	50-ton	"	at Krupp's.
Two "	50-ton	"	in Russia.
Four "	20-ton	"	in France.
Three "	25-ton	"	
One "	35-ton	"	
Two "	40-ton	"	
One "	50-ton	"	
One "	80-ton	"	
Two "	100-ton	"	

The reason and the effect of this overwhelming array of big hammers in France are that French manufacturers have been encouraged by continuous contracts to undertake the great responsibility of the outlay required, and they have furnished a continuous supply of heavy artillery to the forts and the navy of France.

Hydraulic Forging Presses.—Fortunately the steel forging capacity of England is not represented by a comparison with steam hammer power. The forging processes of Whitworth, Vickers, Brown, and Cammell have a capacity in excess of this array of French hammers. The days of the giant hammer are numbered, and the Titan you see here, whose blow disturbs and injures a whole district, will be supplanted by the silent, slow working, but irresistible press. In this new application of mechanical science English steel manufacturers are distinctly well ahead of their foreign competitors, who are only just beginning to derive from England the tools which have long been used and perfected by the makers I have named. I was permitted the other day, by the kindness of Mr. J. D. Ellis, to view the 4,000 ton press of John Brown & Co., which was made by Tannett, Walker & Co., Leeds. The press was working upon an ingot, the original size of which was 52 inches diameter at the bottom, 46 inches diameter at the top, weight about 34 tons. This was reduced in four heats to 29 inches diameter, for a gun tube 28 feet long. The forging press of Cammell & Co., made by Davy Brothers, Sheffield. This is a 5,000 ton press. Mr. Charles Davy has been good enough to furnish me with much valuable information on the subject of press forging. This subject of hydraulic press forging is one which I hope will be brought before this Institution by one of our members. We have several well qualified to inform us upon it. A warm acknowledgment should be made of the inventions of Haswell, Vienna, who was the pioneer in this field, and whose presses have done much work on the Continent in the forging and shaping of iron during a long period of years. When the history of the forging of metals by hydraulic pressure is written, it will not be complete without a record of the invention of our own Sir Henry Bessemer. In 1856 Sir Henry Bessemer obtained a patent for the first application of hydraulic pressure in the manufacture of steel in its fluid and solid state, and in August, 1856, a press drawing was shown at work in his experimental steel works at Saint Pancras, and in August, 1869, Sir Henry Bessemer was granted a patent for the further development of his system of casting under pressure, and in January, 1863, he patented a hydraulic forging press. I have a long and interesting letter from Sir Henry Bessemer on the subject, which I hope to have some other opportunity of communicating. His inventions cover a large field, and are the fruit of more than sixty years of mental activity. May he long live to enlighten and counsel us with his practical experience, his scientific knowledge, and to encourage us by his presence! In endeavoring to make a comparison between the force of a steam hammer and a forging press we must consider the differences of the application of the pressure. The blow of a hammer is instantaneous, the effort is abrupt, and it is expended in a very short space of time, consequently the metal is forced into shape suddenly. The force of the blow is absorbed to a great extent on the surface of the forging, and, if the hammer is under its work, the surface absorption is so great that the forging has a tendency to pipe, and to become hollow and unsound in the center. On the table are two specimens of steel—one hammered, the other pressed; two samples which clearly demonstrate the action of the hammer and the press. A hammer of 100,000 kilos. falling weight has a nominal travel of 5·00 m., which is reduced to 3·50 m. if operating upon an ingot 1·15 m. thick. The work done in lifting the hammer is 100,000 × 3·50 = 350,000 kilogrammes. The work or energy given out in arresting the descent is necessarily equal to the work done in lifting, assuming that the velocity of descent has not been restricted by back pressure in the steam cylinder. The velocity of descent is, however, considerably restricted, part of the energy being expended in forcing the exhaust out of the cylinder; there is a loss due to friction as well. The amount of penetration effected as represented by the distance traveled in arresting the descent of the hammer is dependent on the superficial area of the hammer face and the hardness or softness of the ingot. For these calculations it may be assumed to be 100 mm.

It is now possible to construct a diagram of the pressure exerted upon the ingot by the falling weight.



The horizontal lines represent pressures, the vertical lines represent the space traveled during the retardation. Under the most favorable but really unattainable conditions, the diagram is known to have an area representing 350,000 kilos. of work. The travel being 0·10 m., it follows that the forging must offer an average resistance of 3,500,000 kilos., but the falling weight may be capable of exerting a pressure of 7,000,000 kilos. on its first contact with the forging. The whole operation of bringing the falling part to rest occupies so little time that it is impossible that the pressure of the blow can be felt equally and uniformly through the metal. A press dynamically equivalent to the above hammer would be capable of exerting a constant pressure of 3,500,000 kilos., and the diagram of energy would be a simple rectangle. The time required to effect the impression would be several seconds. As the hammer cannot develop the full amount of energy stored in raising the tup, it is certain that a press of less than 3,500 tons power would be equivalent to a 100 ton hammer.

Electric Welding.—Electrical welding is a process which now has a practical value, and the perfecting of which will afford further opportunity to the engineer, and lead to new applications of iron and steel. The Thomson electric welding machines are now, I am assured, in use in the United States for welding iron, steel, and other metals. The weld is as strong as the same section in another part of the bar, as the heat is first developed in the interior of the part to be welded and joins thence outward as pressure is applied to it. It is claimed that by the use of specifically adapted holders, locomotive frames, angle iron, pipes, T connections, carriage and wagon iron work, etc., and possibly boiler plates, can be thus electrically welded. Rivets are to be heated by electricity when in the holes, having first been fixed when cold.

This opens out a new prospect of expansion. Locomotive boilers and marine boilers, electrically welded, will enable our engineers to work with pressures of which we can only dream at present, and new economies in compounding will still further develop the transport and exchange of commodities, and create new fields for the use of iron and steel.

Water Gas.—Water gas has valuable qualities ascribed to it, from which economy and purity of product are obtained. The subject is an extensive one, and large interests are involved. The council has invited members of this Institute who are concerned in the invention to bring this process before you by papers, by which means it may be explained and discussed.

Iron Alloys.—Much attention has during the last few years been paid to substituting the carbon contained in steel by a metallic substance, thus forming iron alloys which are bound to play a more and more important part in the industry, on account of their special nature and qualities.

Alloys of Iron and Aluminum.—Chemically pure metallic iron is practically unknown; iron containing a very small quantity of carbon is as soft as lead, and when exposed to moist atmosphere it oxidizes very quickly. Wrought or ingot iron, containing say 0·08 of carbon, must already be considered as a compound in the stage toward steel. Ingot iron alloyed with so small a portion of aluminum as 0·1 per cent. melts at

a comparatively low temperature, is very liquid in the molten state, and can be cast into solid and homogeneous objects possessing the strength of wrought iron. The Aluminum Company, which have succeeded in producing aluminum of practically absolute purity, have kindly sent me some samples of their productions, which are on the table before you, embracing examples of ferro-aluminum, aluminum wire, aluminum rods, and other objects. These alloys are finding a large application, on account of the facility with which they are cast, and on account of their strength and ductility, but they are subject to the corrosive influence of moist atmosphere, salt water, etc., in the same, or somewhat larger, degree as iron or steel, while alloys of copper are much improved in strength and ductility by the introduction of a certain proportion of iron.

Iron, Copper, and Zinc Alloys.—These alloys, provided the iron is chemically combined, are not acted upon by moisture, sea water, etc. I exhibit samples of Delta metal, which is an alloy of copper, zinc, and iron—the latter is introduced after being previously alloyed with zinc. A sample on the table of this zinc-iron alloy, containing 22 per cent. of iron and 78 per cent. of zinc, has the appearance of a mineral, and by no means that of the metal of which it is composed; that the iron here is chemically alloyed is proved by the same not attracting the magnet, nor does it rust when exposed to moist atmosphere, or give sparks under friction. Delta metal, although containing only about 3 per cent. of iron, shows, when cast in sand, equal tensile strength to wrought iron, viz., 23 to 24 tons per square inch, and when forged or stamped at red heat its strength is increased about 38 tons per square inch, with 20 per cent. of elongation. Launches and torpedo boats made of Delta metal sheets have been in service some years, exposed to the action of river and sea water, without showing signs of deterioration.

Alloys of Iron and Nickel.—I am glad to see that the subject of the alloys of nickel and iron will be treated in a paper by Mr. James Riley, a member of the council. This alloy promises to be of great commercial value. I have here test pieces of two bars, which were cut out of a 10 ton armor-plate made in France. The pieces were forged down into shape. They contain 5 per cent. of nickel, and give a tensile strain of 90 tons, with an elongation of eight per cent. It is claimed that with 5 per cent. of nickel there is almost entire freedom from corrosion. Nickel steel has extreme fluidity, and is very sound. It is evident that a full consideration of this subject of steel alloys will be of great value and interest to the members of this Institute. Having seen how appliances and methods are increasing our manufacturing capabilities, it is well that we should glance at our prospects and opportunities of using them.

In construction works, the successful completion of the Forth Bridge, which is now assured to be effected during the year 1889, will afford an example of the possibilities of bridging rivers and valleys hitherto impediments to direct communication. This triumph of engineering skill and of practical work stands as a remarkable testimony to the merits of steel, and again shows how opportunely a need is met with a new production. English architects are no longer behind their Continental brethren in the use of iron and steel for architectural purposes, and ever-increasing employment of iron and steel from this development is assured.

Ships.—In considering our future, the condition and prospects of the shipbuilding trade are of vast concern, and it is a great encouragement to know that there is an active and a healthy demand for ships, which we can reasonably estimate will for some time be steady and advancing in its quantity. I find from *Lloyd's Register of Shipping* that there are at present under construction in the United Kingdom 528 vessels, having a gross tonnage of 920,989 tons, being an increase on the same period last year of 148 vessels and 326,563 tons. Roundly speaking, half a ton of iron or steel is required per ton of gross tonnage, and, taking the annual production now required and contracted for as 1,000,000 tons, we have reasonable grounds for calculating upon a demand for some years to come of 500,000 tons of manufactured iron and steel from this source alone. It is encouraging to notice that 398 vessels, having a gross tonnage of 700,000 tons out of 1,000,000 tons, are building for the United Kingdom.

Heavy Rails.—Heavy and powerful engines have been constructed to drive the express trains at higher speed which serve the great cities of the Continent. The limits of these services are restricted as yet by the capacity of the railroads. The rails in service on the main lines of the country have been laid down in recent years of heavier and stronger sections, and although they have not yet attained their maximum, they are distinctly better than those of most of the principal Continental and colonial lines.

My friend, Mr. Sandberg, the inventor of the "Goliath" rail, and an authority on the subject, read an interesting paper on the use of heavier rails before the Institution of Civil Engineers. He related the history of the accident to the Czar's train on the Kursk-Charkov-Azov Railway. The train, weighing nearly 600 tons, including the Czar's sleeping carriage, which weighs about 50 tons, was run at 43 miles an hour on a 66 lb. rail and an imperfect road. The train ran off the line and was wrecked, and many persons were killed.

This condition of road and rail exists on many Continental main lines of railway on which heavy express trains are running, and it is imperative that such lines should be relaid to meet the new conditions of railway service. Some colonial lines have recognized this new want. The Victorian government railways are now taking from the Barrow Steel Company the "Goliath" rail, a flat bottomed rail, 100 lb. per yard, a section of which lies on the table. I will not treat you to anything more than a passing remark on the subject of technical education. It is very clear that elementary training in physical and mechanical science and in drawing is essential to the managers of iron and steel works.

A glance at the list of subjects which engage our attention this week is proof enough. An intelligent German, quoted by Sir Henry Roscoe, made the observation, "While you in England have been busy for the last half century in perfecting your machines, we in Germany have been busy in perfecting our men." There is sound truth and serious warning to us in this observation, though it is open to the retort that English machines and English invention have been perfected by Englishmen. Still manufacturers and workmen like myself, who can but touch the fringe of scientific knowledge which rules and develops our processes, are conscious that we must do our utmost to secure for our workers scientific training which shall afford to the rising generation a wider knowledge and a fuller light.

It is well for us that we meet to-day under better trade conditions and brighter prospects than we have for some time past. The revival of trade, which is general, has not happily reached the iron and steel trade through any special source. It is no American "boom," but a world-wide demand, which has infused life and general activity into our furnaces and our rolling mills.

This is not an Institute for the consideration of commercial questions, but I will venture to utter one word of counsel with the experience of the past years so full upon us. The inflation of the years about 1873 led to an unreasonably rapid development of the means of production throughout the world, which was not followed by a corresponding increase of the needed demand. The facility which limited liability laws give for the acquisition of capital for new works enables new plant to be laid down at a rate and on a scale which was impossible to our private concerns which grew out of profits made in the business; so, although developments were not denied, they were, it seems to me, of more natural and more healthy growth. Years ago, an old friend of the town of Leeds, Sir Edward Baines, in a speech on commercial matters, quoted a Latin motto which sank into my mind as one which ought to be remembered by commercial men. It was "Festina lente" (make haste slowly). It is true all iron and steel works in this country are actively employed, many with forward contracts, but the make is immense. In the United Kingdom we produced in the year 1888 169,935,219 tons of coal, exceeding by 6,198,219 the largest output of any previous year of the history of the trade.

We produced 7,898,634 tons of pig iron, 2,012,794 Bessemer steel ingots, 1,292,743 open hearth steel ingots, and we must remember that we began this year with a stock of 2,516,212 tons of pig iron, which is decreasing but slowly.

We have alert and instructed competitors in every neutral market, while fiscal restrictions interfere with our trade in most Continental countries, and any serious advances in the price of materials would endanger the trade we are now securing.

Let us develop our appliances and improve our processes with care, prudence, and wisdom, then will our progress be sound and secure. *Festina lente.* (Loud cheers.)

NOTE ON THE MOMENTUM OF STEAM IN STEAM PIPES.

By Prof. J. E. DENTON.

UPON applying an indicator to both the cylinder and steam pipe of a 13×34 inch Brown automatic cut-off engine, Mr. F. M. Leavitt obtained the diagrams shown in Fig. 1. The upper diagram represents the fluctuations of steam in the steam pipe about 12 inches from the steam chest.

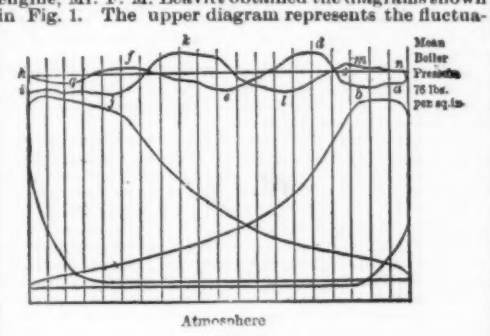


FIG. 1.

It is evident from inspection that when the cut-off valve closed, the pressure in the steam pipe increased along the line, *b d e*, and then undulated like a sound wave, as represented by the line, *d e f g h*, until interrupted by the opening of the valve at the end, *h*, of the cylinder. The pressure then fell to *i* and continued practically uniform to *j* when, cut-off again occurring, the wave-like fluctuations were repeated along the line, *j k l m n*.

As Mr. Leavitt verified the accordance of the scale of his indicator with the boiler pressure gauge, it is certain that the line, *h n*, accurately represents the boiler pressure, and we are therefore confronted with the remarkable fact that the pressure at the point, *d*, is about six pounds above that in the boiler. The only explanation of such a phenomenon is that the momentum of the steam in the steam pipe causes the excess of pressure above that prevailing in the boiler, and it is the object of this article to show that a computation of the momentum of the steam contained in the pipe approximately confirms the possibility of the pressure at *d* being six pounds above that indicated by the line, *h n*.

To this end Fig. 2 is drawn, showing the steam pipe

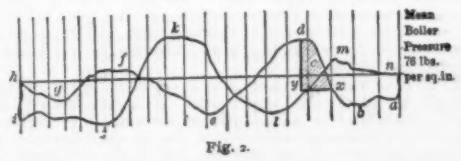


Fig. 2.

diagram to a vertical scale twice as coarse as in Fig. 1, and the vertical space lines are made to represent equal intervals of time, corresponding to one-twentieth of a half revolution of the crank. The latter made 90 revolutions per minute. Hence each space represents

$$\frac{60}{90 \times 40} = \frac{1}{60} \text{ of a second of time.}$$

The steam pipe was five inches in diameter and about 40 feet in length. Its cubical contents were, therefore, about 9,500 cubic inches, or 1·13 pounds of steam at boiler pressure.

From the known consumption of steam per horse power of the engine, the velocity of steam in the pipe is computed to be 70 feet per second. The momentum of the pipe full of steam is therefore,

$$\frac{70 \times 1{\cdot}13}{32} = 2{\cdot}47 \text{ units.}$$

Let p = the mean pressure per square inch which, exerted for a time t, will neutralize this momentum. Then we must have by the rule of mechanics which makes "impulse" = "momentum": $A \times p \times t = 2{\cdot}47$. A being the area of cross section of the 5 inch steam pipe, or 20 square inches in round numbers. Hence,

$$p = \frac{2{\cdot}47}{20 \times t}$$

Let it be noted that the drop of pressure, *n a*, Fig. 2, is practically due to the friction of the steam moving at high velocity in the steam pipe. As soon as the velocity is checked this friction is reduced, and the steam would, therefore, tend to rise in pressure from *b* toward *c*, even if there were no effect due to momentum. Let it be assumed that this tendency to recover boiler pressure due to reduction of friction causes the rise of pressure represented by *b x*. Then the effect due to momentum would be represented by the action from *x* to *d*, which occupies about $1\frac{1}{4} \times \frac{1}{20}$ second of time. Let this equal the value of t in the formula for p. Then

$$p = \frac{2{\cdot}47}{20 \times 1\frac{1}{4} \times \frac{1}{20}} = 6{\cdot}03 \text{ pounds,}$$

which should be the mean ordinate of the shaded area, *x y d x*. The mean ordinate of this area is found to be actually five pounds. Hence the momentum of the stream is sufficient to account for the existence of the point, *d*, provided about one-fourth the total rise of pressure, *b d*, is assumed to be produced by the tendency of the steam to recover boiler pressure through its own elasticity when the friction due to flow partially subsides.—*Stevens Indicator.*

POWER TEST OF THE DAFT ELECTRIC RAILWAY AT ASBURY PARK, N. J.

By F. E. IDELL, M.E.

THE attention of the street railway companies is being drawn, more and more, to the question of reducing the cost of transportation. They are aware of the fact that new systems are being introduced, and they are ready to adopt these new systems, provided they can do so at a saving in the cost of motive power. Under the present system of horse traction the railway companies are compelled to keep on an average nine horses per car. Metropolitan lines generally allow twelve horses per car. When this average is lowered, the horses must do a duty of from fourteen to fifteen miles per day, and the depreciation is rapid. Under a wise management the duty is limited to about ten miles per day. The principal railway companies estimate the life of their horses at from three to five years. Mr. A. W. Wright, of Chicago, says that the cost of the horse department is from 30 to 40 per cent. of the operating expenses of the horse roads in Chicago. Mr. D. K. Clark states that the cost of the horse department of the Leeds Tramway Co., in 1876, was 61 per cent. of the total expenses. In 1880, the cost of the horse department of the London Tramways was between 40 and 50 per cent. of the expenses. Consequently, any saving in the cost of motive power is of the utmost importance to street railway companies.

When other means of motive power than the horse were to be introduced, it became necessary to ascertain the power required to start a car and maintain it in motion. Mr. A. W. Wright made a series of experiments to determine the amount of power necessary to start street cars, and to maintain them in motion at an average speed of five miles per hour. He found that it required a force of 116·5 pounds per ton to start a car, and 15·6 pounds per ton to keep it in motion. These figures are for good tracks. On a bad track he found that it required 134·6 pounds per ton to start a car, and 32·3 pounds per ton to keep it in motion. General Gillmore estimates, for the United States, an average of 16⅔ pounds per ton to keep a car in motion with tracks in average condition. Mr. D. K. Clark gives us as an average thirty pounds per gross ton as the usual resistance; he states that "an occasional maximum of 60 pounds per ton may be reached, and, on the contrary, a minimum of say 15 pounds per ton, when the rails are wet and clean, straight and new."

Mr. Clark's experiments were made on grooved rails, which offer a greater resistance than the step or center bearing rail. In illustration of the resistance due to the flanges, he gives an instance of a car having four flanged wheels, which was drawn over the Paris and Versailles Tramway, when the tractional resistance amounted to 22·4 pounds per ton. Three of these flanged wheels were removed and replaced by three flat tired wheels. Upon test, the tractional resistance was about eleven pounds per ton. For starting cars he gives from 100 to 120 pounds per ton for the tractive force.

The resistance of curves cannot be determined as accurately as the straight track. In writing on resistance of curves, Mr. Wright says that with the same car and load he found the force exerted on curves to vary between 400 and 1,000 pounds, and the greatest exertion of force upon a curve, when starting a loaded car was 1,500 pounds, or 283·5 pounds per ton.

Taking a specific case, a 16 foot open car, weighing, with a 15 horse power motor, 6,200 pounds, and its complement of passengers at 140 pounds each, the total load would be 13,200 pounds or 6·6 net tons. To start this car on a curve, with a speed in starting from 0 to 528 feet per minute (equal to six miles per hour) averaging 264 feet per minute, would require

$$\frac{6{\cdot}6 \text{ (tons)} \times 283{\cdot}5 \text{ (lb.)} \times 264 \text{ (ft.)}}{33{,}000} = 15 \text{ H. P.}$$

In general service only a small portion of this power would be required, but a maximum of 15 horse power must be kept in reserve.

The power required to keep the car in motion on a straight and level track, at a speed of six miles per hour, is:

$$\frac{6{\cdot}6 \times 15{\cdot}6 \times 528}{33{,}000} = 1{\cdot}64 \text{ H. P.};$$

and for starting the car on a straight and level track

$$\frac{6{\cdot}6 \times 116{\cdot}5 \times 264}{33{,}000} = 6{\cdot}15 \text{ H. P.}$$

It is, therefore, evident that, at times, two horses must necessarily exert several horse power.

Practical railroad men, when approached on the subject of adopting electric traction in place of horses, cannot understand why the electrical companies should place 15 and 20 horse power motors under each car. "Why," they say, "we get along with two horse power." They fail to recognize the fact that the car horses are called upon, at times, to exert from five to ten times their normal force, and completely ignore the number of horses per car in use on their own lines, which experience has shown to be necessary for the performance of continual daily service.

The average force which a horse can exert at a speed of 2½ miles per hour is placed at between 100 and 150 pounds. The experiments of Mr. Wright show that a horse is capable of exerting for a *short* distance 1,530 pounds, or more than ten times the average figure. Under such severe duty it ceases to be a surprise that the average useful life of car horses is reduced to four years.

What can be accomplished, electrically, in street car propulsion is shown in the following account of the electric railroad at Asbury Park, N. J., equipped with and operated by the Daft system. It is an example of overhead conduction, the outgoing and return currents being conveyed through parallel wires suspended over the track. The road is a belt line and, with the exception of that portion along Cookman Avenue, is single track, with switches placed at given distances. The maximum grade is 1 per cent. and the curves 50 feet radius.

At the time of the test 14 cars were running on the road, six each way around the belt and two along Cookman Avenue, between the railway depot and the beach. A 15 horse power motor is placed under each car and is carried by two I beams resting on the axles. The armature shaft transmits its motion to the axle of the car by means of spur gearing. By means of a "trolley" and "tow line" the current is carried from the overhead wires to the electric motor. The current for each car is regulated by means of a switch box, at both ends of the car, under the control of the driver or "motor man." This enables him to start gradually and without shock, and, when once in motion, to obtain the maximum speed in the minimum of time.

The power station is located on the west side of the tracks of the New York and Long Branch Railroad, on the corner of Railroad and First Avenues. It is a frame building 48 × 90 feet, and is well lighted and commodious. Between the boiler room and engine room is a 12 inch brick wall, which is carried beyond and above the building and serves as a fire wall. The main current leads are run from the station about two blocks before they join the loop connecting with the trolley wires.

In the boiler room there are three steel tubular boilers, built by the Phœnix Iron Works, of Meadville, Penn., of 85 horse power each. These boilers are set in one battery far enough away from the sides of the building to permit the fireman to pass around them. A duplex pump is set alongside the boilers and an injector is placed on the boiler wall over the pump.

In the engine room there are four Dick & Church automatic engines, of 60 horse power each when running at 300 revolutions per minute under 80 pounds initial pressure of steam. These engines have piston valves. The live steam in the valve chest surrounds the valve seat or casing, and in consequence the casing expands before the valve; the valve can, therefore, be fitted very closely without danger of leakage or sticking.

The engines, when running, are belted to a line shaft carried on brick piers placed in the center of the room. Five dynamo generators, each of 50 horse power capacity, are belted to the shaft on the side opposite to the engines. The switch board is placed on the wall of the building near the dynamo generators, which are run in multiple. During the test three engines and three dynamos were in use. The steam piping is of sufficient size to allow for an enlargement of the plant to twice its present capacity—and at the time of the test was uncovered. The exhaust pipe is led under the floor to the feed water heater, which is placed in the corner of the engine room.

The test of the power required to drive the cars at Asbury Park can be separated into two parts, viz., the boiler test and the engine test, and will be considered in this order.

BOILER TEST.

The boilers are 60 inches diameter, 14 feet long, with 82 three inch tubes 14 feet long. Each boiler contains 1,090 square feet of heating surface. The smoke stack is 44 inches in diameter (10·5 square feet), and the top is 60 feet above the grates. The grate surface under each boiler is 22·5 square feet, making the total for the three boilers 67·5 square feet. The ratio of grate to chimney area is as 6·45 to 1, and to heating surface as 1 to 48·4. During the test two boilers were used.

The test was commenced at 5 A. M., August 28, ended at 12 midnight, August 30, 1888; making the total period 55 hours. Steam was raised in the boilers to a pressure of 70 pounds per square inch at 4:30 A. M., when the fires were drawn, the grates and ash pits cleaned, and a new fire started at 5 A. M., with 106·5 pounds of wood (42·6 pounds combustible). The height of water in the boilers was the same at the end of the test as at the commencement. The water was measured by a "Crown" water meter, which was, by test, found correct. A duplex pump forced the water through the feed water heater into the boilers. A constant feed was maintained during the test. The average temperature of the feed water just before it entered the boilers, for the whole test, was 207° Fah. Half-hourly readings were taken of the steam pressure, temperature of the feed water, and temperature of the boiler room. Readings of the water meter were taken every hour, and also the weight of coal delivered to the fireman. The ashes resulting from each day's run were weighed the following morning.

The total amount of coal delivered to the fireman, including that used for banking two nights, was 27,783½ pounds. The total weight of ash was 4,211 pounds, or 15 per cent. Included in this is ash, clinker, and such unburned coal as had dropped through the grates.

The total fuel was:

Coal	27,783·5	pounds
Wood	42·6	"
	27,826 1	"
Less ash, etc.	4,211·0	"
Combustible	23,615 1	"

The total amount of water fed to the boilers at 207° Fah. was 253,812·5 pounds. The average steam pressure per square inch was 77 pounds.

The pounds of water evaporated per pound of coal under actual conditions were 9·1; the pounds of water per pound of combustible at actual pressure, 10·74; and the pounds of water evaporated per pound of combustible from and at 212°, 11·04.

ENGINE TEST.

The engine test was commenced on August 29, at 6:15 A. M., and ended August 30, 1888, at 10:30 P. M., making a total period of 35 hours. Two indicator cards were taken from each of the three engines in operation every 20 minutes during the day, and half-hourly during the evenings. The engine friction was found to be 10·03 horse power, 6·47 horse power, and 6·13 horse power, respectively.

The excessive friction of the first engine was probably caused by some journal box or gland being set up too much; it could easily have been lowered to the other figures, had there been time to make the correction, but as the test was in progress this could not be done.

The greatest indicated power obtained during the test averaged 8 horse power per car. This includes the friction of the engines, shafting, dynamo generators, loss due to the electric resistance of the line and the resistance of and work done by the motors. The average power consumed in each motor was only 1·9 horse power. This figure is the result obtained from 450 indicator cards.

The regulation of the engines was excellent. Before commencing the test, the engines were run in pairs to see if they drove the shafting at the same speed. The shafting could be separated into two parts by throwing out a friction clutch coupling, which permitted of running the four engines at one time. A tachometer was placed on the floor at one end of the line and belted to the shaft, and the speed was noted. Then the tachometer was taken to the end of the second length of shafting, belted to it, and the speed again noted. The difference in the readings was one revolution per minute, or, at the speed the shafting was running—337·5 revolutions per minute—the error was about $\frac{1}{15}$ of 1 per cent.

During the test, readings of the tachometer were taken half hourly; the average for the two days was 335 revolutions per minute, which is about $\frac{7}{15}$ of 1 per cent. below the normal speed.

The variation in the demand for power upon the engines was, at times, as great as 17 horse power within the period of two minutes, and under these extreme conditions the regulation of the engines was exceedingly good. The governor acted very promptly, as the variation in speed lasted but a few seconds, and the record of engine revolutions when the indicator cards were taken was uniformly so near 300 per minute that this figure was used in working up the cards.

The number of pounds of coal per horse power, on an average hour, was 5·9. In the calculation for this figure and those following, the coal used in banking the fires on both nights of the test is taken into account, the object in so doing being to give the results of actual working conditions. With reference to the consumption of coal per horse power, it will be noted that there were in operation three engines rated at 60 horse power each, or 180 horse power total, developing a maximum of 112 horse power, while the average horse power for the two days' run was less than one-half the normal rating of the engines. Under these unfavorable conditions the economy could not be as great as if they were running at full load. But taking the plant as found, the economy is very near the figure obtained from high speed engines under very much more favorable conditions of load.

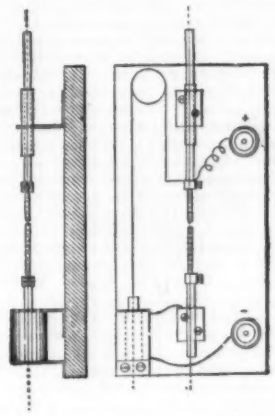
The average number of passengers per trip during the test was 23, or, with "motor man" and conductor, 25. The average load was, therefore, 25 × 140 = 3,500 pounds, and the total load, including the weight of car motor, 9,700 pounds, or 4·8 tons. The average time per round trip of 3½ miles, including numerous stops for passengers, was 40 minutes. The first trip in the morning is generally made in 20 minutes. The average rate of travel was, therefore, 5·7 miles per hour, with a maximum of 11·5 miles per hour. The total amount of coal consumed per car per hour was 36 pounds, or 1·31 pounds per ton per mile.

With a power plant capable of driving 20 cars, and running but 14, the cost of motive power per car, in use, was about $3.13 per day of 17 to 18 hours. This includes interest and depreciation on the cost of the power plant, motors under the cars and overhead system, wages of two engineers and two firemen, coal, oil, waste, and water.

If 20 cars were run, the cost of motive power would be about $2.68 per car per day. If horses were used, 140 to 200 would be necessary for the same service, and the cost of keeping these would be at least fifty cents per day per horse, or $5 per car per day. Interest on investment in horses and stables would increase this figure to $5.50 or $6 per car per day. Consequently, at Asbury Park the electric road is being run at one-half the cost that a horse road would be in the same locality. Here the electric road has a decided advantage, for during the winter months but four cars are run, requiring one boher, one engine, and one dynamo generator, and, while the cost per car for motive power is higher than in the summer months, it is still lower than it would be with animal traction. This is due to the fact that the horses, if kept, would cost from fifty to sixty cents per horse per day, whether doing work or not, and even if the number of horses were reduced by sale to 40, those sold in the fall of the year would bring but a very small price after the severe work of the previous summer, and a new stock of from 120 to 160 would have to be purchased in the following spring at a high price. This difference when charged against the motive department would make the average cost per car per year very much greater than for the same number of cars on a road using electricity as a motive power, which loses only the interest on the investment during the winter.—*Stevens Indicator.*

SIMPLE ARC LAMP.

HAVING occasion some time back to give an exhibition of the electric light, and having no lamp at hand, I constructed the one shown out of various odds and ends lying about a workshop.



The solenoid was made from two pieces of brass ⅛ in. thick or so to form the end cheeks, one of which was bent out as shown to form the foot for attachment to wood base; these were soldered to a piece of ⅜ in. brass tube 2⅛ in. long, and dimensions of coil inside were 2 in. long by 2 in. diameter; this held ½ lb. No. 16 B.W.G. double C.C. wire easily, but 6 oz. was plenty. The core was 3 in. long by ⅝ in. diameter, and was a shade heavier than top carbon holder and carbon, and was adjusted so that when the carbons were in contact the core protruded about 1½ in.

Connection between top (+) carbon and terminal was by a spiral of copper strand; adjustment for current was by weights on top of (+) carbon holder. I found that to get a steady light the core had to be rather more than half way through solenoid; and to check "hunting" I applied a light spring to introduce friction to the movement of upper rod.

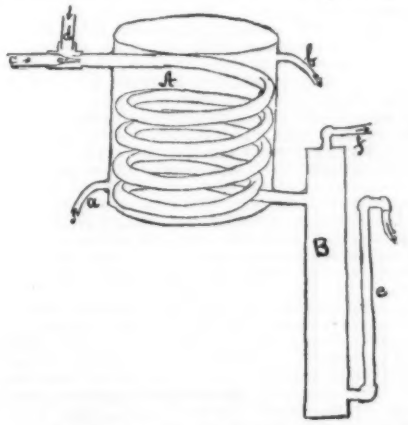
Diameter of carbons, 4 millimeters "Hardtmuth," from Woodhouse, Rawson & Co. (judged from light given), about 6 or 7 amperes.

I may mention that the light was seen four miles off by a man who made out he was shooting wild ducks by the light given, and that in the town some quarter of a mile off it was thought by some that the house was on fire. The light being a novelty there, a crowd of some 200 persons were in the street in front inside of half an hour. The first trial was made with a solenoid consisting of only about one dozen turns of No. 18 braided wire (which we had handy), and stapled to the board.—*George T. Pardoe, in The Electrician.*

STEAM SUCTION BLAST AND STILL.

THE accompanying cut illustrates an apparatus in use in the analytical laboratory of the St. Louis Ore and Steel Co Their chemist (Mr. A. Van Zwaluwenburg, Ph.G.), under whose directions the apparatus was constructed, states, says *The Pharmaceutical Era*, that it has been in use during the last two months and has given perfect satisfaction.

A is an ordinary condenser with the cold water inlet at *a* and the exit at *b*. Steam enters the coil of the



condenser through the tube, *c*, which at *c'* is reduced in size to ¼ inch. *c* is connected with the coil by a ⅜ inch T. As the steam is injected into the coil it carries with it air, which is drawn in through *d*, creating a suction that may be used as a filter pump. As the mixture of steam and air passes through the coil, the steam is condensed, the mixture of air and water enters the separator, B, the water is carried off through *e*, while the air is forced out of *f*, producing a blast that is sufficient to run six Bunsen blast burners.

This simple apparatus, though not entirely new, is an excellent combination, furnishing a good filter pump, a steady blast, and distilled water. The apparatus may be made by any steam fitter at a small cost.

INSTRUMENTS FOR DRAWING CURVES.

By Prof. C. W. MACCORD, Sc.D.

NO. IV.—THE SINUSOID, OR HARMONIC CURVE.

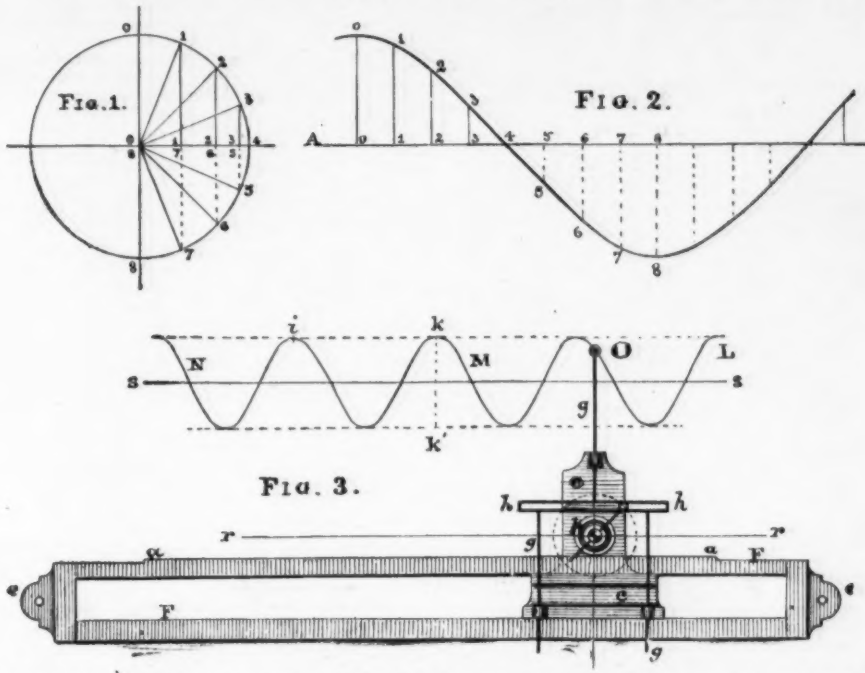
IN Fig. 1, let the circumference of the circle be divided into equal parts at the points 0, 1, 2, etc., and let a perpendicular be drawn from each point to the horizontal diameter. Then dividing the horizontal line A B, in Fig. 2, into equal parts of any length, set up at the points of division the vertical ordinates 00, 11, 22, 33, etc., equal to the corresponding ordinates of the circle: the curve thus determined is the sinusoid, or curve of sines, called also the harmonic curve, as being the curve in which a string vibrates in producing a musical note.

From the above construction it is clearly a very simple matter to devise a means of tracing this curve mechanically by continuous motion, and the skeleton of an instrument which will do it is shown in Fig. 3. It consists merely of a frame F, which may be secured to the drawing board by pins at *e e*. A slot in this frame guides a carriage *c c* so that it shall slide freely in a horizontal line. In this carriage is the bearing of a small wheel *p*, which rolls on the top *a a* of the frame F, which should be made into a rack engaging with teeth upon the wheel. The shaft of the wheel carries a crank, whose pin works in a slotted crosshead *h h*, which is compelled to move in a vertical direction only by means of three rigid rods *g g g*, sliding in guides fixed to the carriage *c*. A pencil O is carried by one of the rods *g*, and will trace the sinusoid L M N, the height K K′ of the wave being equal to the throw of the crank (which may be made variable by obvious means), and the wave length K *i* being equal to the circumference of the pitch circle of the wheel *p*. The center of the wheel travels in a horizontal line *r r*, and the harmonic curve is symmetrically divided by the corresponding horizontal line *s s*, which corresponds to A B in Fig. 2, and is the axis of the curve.

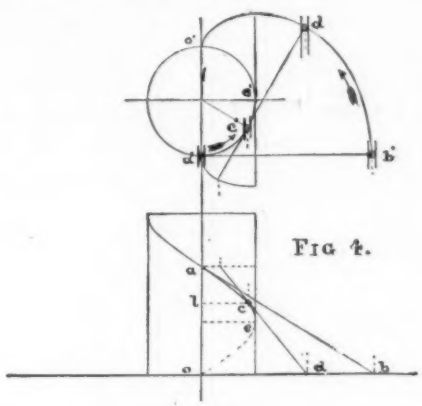
We have then an instrument which will draw a curve, and it will draw it well, in pencil. But it has the defect, common to the most of such instruments, that no provision is made for guiding the blades of a drawing pen in the direction of the curve. So far as the utility of a mere drawing instrument is concerned, we have previously expressed the opinion that this is of minor consequence; for we do not believe that appliances of this class are practically worth their cost to a draughtsman.

But mechanism capable of just such definite and accurate motions may prove very useful for other purposes, as, for example, in the shaping of cams to the exact forms which may be required; in view of which the solution of such problems is not an unprofitable exercise.

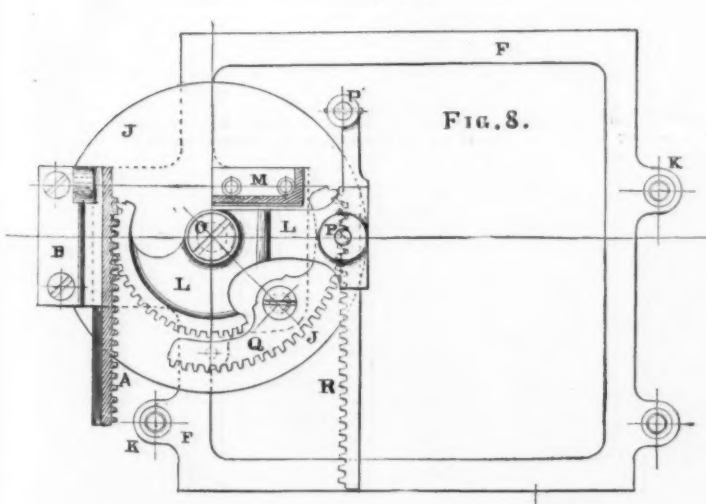
In the present case, the available properties of the tangent to the sinusoid are most easily deduced by regarding the curve as the projection of a helix on a plane parallel to its axis. Thus, in Fig. 4 is shown a vertical cylinder standing on a horizontal plane, upon the surface of which is drawn a helical line, to which *a b* is tangent at *a*. Since the helix may be formed by rolling the tangent line upon the cylinder, keeping the angle of inclination to the horizontal plane constant, the point *b* must remain in that plane, and trace the involute of the circle of the base, as shown in the top view. The point *c* of the helix appears as *c′* in the top view, whence *c′ d′*, tangent to the circle, is the horizontal, and *c d* is the vertical, projection of the tangent to the helix at *c*.

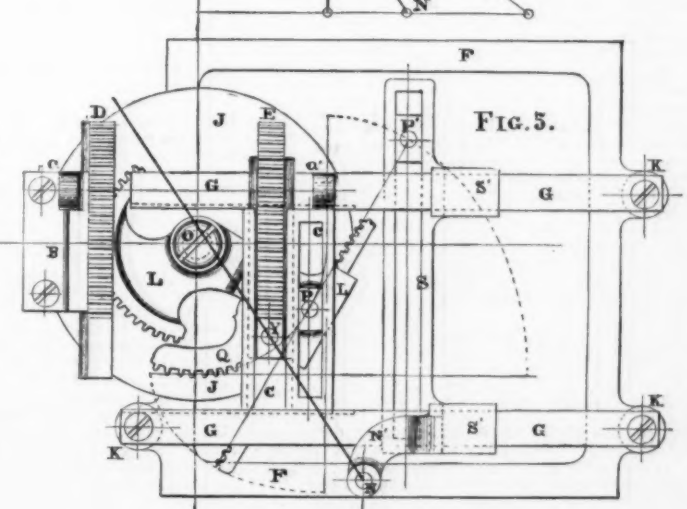


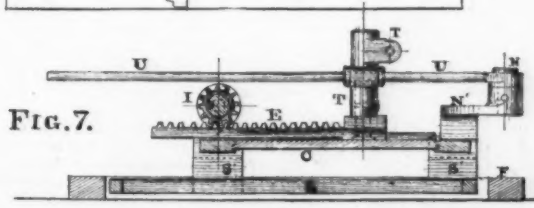
In order to trace the sinusoid, then, a marking point starting at *a* must move uniformly in the direction *a l*, and also move in the direction *l c*, at a rate such as would be given to a slotted crosshead by a pin at *a′* moving uniformly in the circular arc *a′ c′*. And that a right line *a b* may remain tangent to the curve, it must pass always through the moving point, and a fixed point of it *b* must move from *b* toward *d* at a rate such as would be given to another slotted crosshead moving in the involute curve *b′ d′* as shown in the top view.

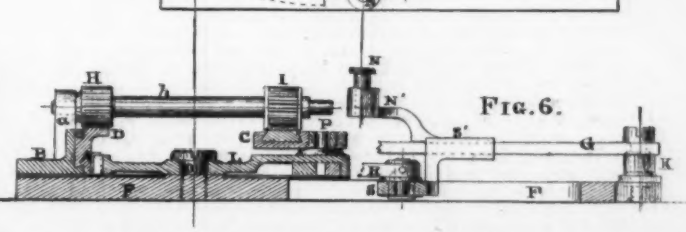


A means of accomplishing these results is shown in the following figures: Referring first to Fig. 8, there is a frame F, upon which is fixed a toothed quadrant Q, a thin disk J, being interposed to support the rack R, which rolls around the quadrant, being kept in gear by a lip projecting downward from the limb L, which turns around the fixed center O of the quadrant. The rack R carries a pin P′, projecting downward, and working in a block sliding freely in the slotted piece S, which is carried by sockets that also slide freely on the guides G G, as shown in Figs. 5 and 6. The limb L carries a pin P, projecting upward, and working in a block sliding freely in a slot in the carriage C, which also slides freely in grooves cut in the inner edges of the guides G G. In the top of C is cut a dovetailed groove, in which slides freely a piece E, upon the upper face of which is cut a rack which engages with the pinion I. This pinion is shrouded at each end, and the shroudings compel it to slide along its shaft, while it is compelled to turn with the shaft by means of a spline, shown in Fig. 7. This shaft *h* is formed of one piece with the pinion H, Fig. 6, which engages with the rack D formed on the upper face of a piece which slides in a dovetailed groove in the piece B, secured to the frame F. One of the bearings, *a*, of the pinion shaft *h* is formed in one piece with B, the other, *a′*, being formed on the top of one of the slides G, as shown in Fig. 5; this slide is supported by a foot M, shown only in Fig. 8, and also by a short standard K.









The limb L is further provided with a toothed

quadrant, engaging with a rack A, on the inside of the sliding piece, upon the upper face of which the rack D is cut.

It will thus be seen that if the rack R rolls round the quadrant with uniform angular motion, the pin P turns about O at the same rate, thus causing C to travel with the required variable velocity, in the direction of the guides G G, while E will also travel with uniform velocity in a direction perpendicular to the guide. Thus any point of E will trace a sinusoid. At the same time, P describes a portion of the involute of the pitch circle of Q, and thus communicates the required variable motion to S.

At Y there is fixed in E a pin projecting upward, upon which turns freely the socket T, shown only in Fig. 7. This is drilled transversely, allowing the bridle rod U U to slide freely through it. One end of U U is formed into an eye, which turns upon the pin N, fixed in a curved carrying arm N', projecting from one of the sockets S'; and the points Y and N in Fig. 5 being properly situated relatively to each other, this bridle rod will remain tangent to the path of Y throughout the action, which is limited to one-fourth of a rotation of P about O. The upper part of the socket T is split, and provided with suitable lugs and a binding screw, thus forming a clamp for the insertion of a pencil or pen, which will trace, during the action just mentioned, the curve V Y W shown in the diagram Fig. 9, corresponding to *e c a* in Fig. 4, being the projection of one-fourth of a coil of the helix. In this curve, V Z, the radius of the cylinder upon which the helix would lie is evidently equal to O P in Fig. 8, being the radius of the pitch circle of the quadrant Q; and Z W, one-fourth of the linear pitch of the helix, is equal to one-fourth of the pitch circumference of the toothed quadrant carried by the limb L; whose radius is, of course, arbitrary.

Although the apparatus as here designed is capable of drawing only a quarter of one wave of the harmonic curve, it need hardly be pointed out that, since the other three-quarters are precisely the same, this is sufficient to illustrate the principles upon which the solution of the problem depends. And as will subsequently be shown, we shall be able, by analyzing the motions of this little piece of mechanism, to deduce a very simple method of ascertaining geometrically the radius of curvature at any point of the sinusoid.

[FROM THE CHRISTIAN ADVOCATE.]

THE OLD OAKEN BUCKET.

WITH what anguish of mind I remember my childhood,
Recalled in the light of a knowledge since gained;
The malarious farm, the wet, fungus-grown wildwood,
The chills then contracted which since have remained;
The scum-covered duck-pond, the pigsty close by it,
The ditch where the sour-smelling house drainage fell;
The damp, shaded dwelling, the foul barnyard nigh it,
But worse than all else was that terrible well,
And the old oaken bucket, the mould-crusted bucket,
The moss-covered bucket that hung in the well.

Just think of it! Moss on the vessel that lifted
The water I drank in the days called to mind,
Ere I knew what professors and scientists gifted
In the water of wells by analysis find:
The rotting wood fiber, the oxide of iron,
The algæ, the frog of unusual size,
The water impure as the verses of Byron,
Are the things I remember with tears in my eyes.
And to tell the sad truth, though I shudder to think of it,
I considered that water uncommonly clear,
And often at noon when I went there to drink it,
I enjoyed it as much as I now enjoy beer.
How ardent I seized, with hands that were grimy,
And quick to the mud-covered bottom it fell;
Then reeking with nitrates and nitrites, and slimy
With matter organic it rose from the well.

Oh! had I but realized in time to avoid them,
The dangers that lurked in that pestilent draught,
I'd have tested for organic germs and destroyed them
With potassic permanganate ere I had quaffed;
Or perchance I'd have boiled it, and afterward strained it
Through filters of charcoal and gravel combined;
Or, after distilling, condensed and regained it
In potable form, with its filth left behind.
How little I knew of the dread typhoid fever
Which lurked in the water I ventured to drink;
But since I've become a devoted believer
In teachings of science, I shudder to think.
And now, far removed from the scenes I'm describing,
The story for warning to others I tell,
As memory reverts to my youthful imbibing,
And I gag at the thought of that horrible well,
And the old oaken bucket, the fungus-grown bucket,
In fact, the slop bucket that hung in the well.

J. C. BAYLES,
Pres. New York Board of Health.

A CONFERENCE OF REPRESENTATIVES OF AMERICAN POWERS.

IN accordance with a bill of which Senator Frye has the high honor of being the father, or one of the principal movers—a bill which was approved by President Cleveland on May 24, 1888—provision has been made by the United States government for a conference at Washington, in the year 1889, between representatives from the United States and the republics of Mexico, Central and South America, Hayti and San Domingo and the empire of Brazil. President Cleveland, upon whom devolved the authority to name the date on which this highly interesting meeting of delegates from widely separate portions of the American continent is to assemble, named October 4 as the date of the convening of the conference—a date likely to become peculiarly historic in the history of the American continent. The delegates to this meeting are to deliberate upon subjects of continental interest, such as the following: "Measures that shall tend to preserve the peace and promote the prosperity of the several American states." "An agreement upon and recommendation for adoption to their respective governments of a definite plan of arbitration of all questions, disputes, and differences that may now or hereafter exist between them, to the end that all difficulties and disputes between such nations may be peaceably settled and wars prevented." "The establishment of regular and frequent communication between the ports of the several American states and the ports of each other." "The adoption of a common silver coin, to be issued by each government, the same to be legal tender in all commercial transactions between the citizens of all the American states." Perhaps the most important of the various paragraphs of the bill reads thus: "And to consider such other subjects relating to the welfare of the several states represented as may be presented by any of said states which are hereby invited to participate in said conference."

For the incidental expenses of this gathering, such as the paying of interpreters and the translation of speeches and papers into the English, Spanish, and Portuguese languages—the languages which will be most used at the conference—and for the payment of all necessary expenses of the delegates, the United States government has appropriated seventy-five thousand dollars.

The assembling of representatives of the various American powers to endeavor by wise counsel and united effort to promote the best interest of the western hemisphere will be the realization of one of the noblest conceptions of the highest, and grandest, and most beneficent American statesmanship. It may be the means of setting in train elements which will in time effect a union of material—and in various respects, of political—interests between all the people of the western hemisphere. It may be to the people of the American continent nothing less than the first steps toward a continental union of states, such as were the first meetings of representatives of the various English colonies, which in time led to the formation of a confederacy, and later into a union, of states—a union which has been one of the happiest as well as one of the most momentous events in the history of the New World.

While European monarchs are given to making secret compacts or alliances with each other, alliances of a kind which are sometimes sadly hostile to civil liberty, and are even disposed, there is reason to fear, to establish, as far as they dare, a policy which would make the interests of parts of the American continent subsidiary to their own ambitions, it is to be hoped that American powers will be a unit in maintaining some wise, beneficent, and far reaching political principles respecting the American continent. They can scarcely expect, however, to ever become such a unit unless the people of all parts of the American continent become better acquainted with each other than they have been in the past. The establishment of lines of steamships between the different ports of North and South America will naturally result from the meeting of this conference. It is to be hoped, even, that among the great subjects of continental interest which will be considered, and will be in due time laid before the governments represented at the conference, will be the building of a great intercontinental railroad running longitudinally across the American isthmus, which, as a great natural bridge, unites North and South America—thus uniting the vast railroad system of North America with the roads of South America.

Separated not even by a strait from North America—on the southern side of the superbly beautiful land known as the American isthmus—is a land about the size of two Europes. Its greatest length is 4,700 miles and its greatest breadth about 3,200 miles. It covers an area which may be calculated at about 7,000,000 square miles. One may well be enraptured as he contemplates the vastness of its natural wealth. Its river system is the grandest in the world. The Amazon River and its tributaries, not to speak of other rivers in that golden land, drains an area of country which is estimated to be 800,000 square miles larger than is the great valley of the Mississippi. In the year 1880 there were probably more than thirty—perhaps more than forty—millions of people in South America. Its population is fast increasing by European emigration. European statesmen may well be amazed as they think upon the smallness of the trade carried on between the people of North and South America. For a long decade—until John Roach, the American shipbuilder, tried to bring about a better state of affairs—there was not a single line of American steamships plying between the ports of North and South America. European governments for once were more sagacious than was American statesmanship, and aided in various ways lines of steamships to ply between their ports and South America, while the government of the United States left John Roach unaided to carry on an unequal struggle with subsidized rival European lines.

Providentially the republic of the United States has geographical advantages in respect to its intercourse with South America which can, by wise statesmanship, be turned to such good account that a trade far vaster and more advantageous to the people of America can be carried on between the United States and South America than Europeans can, in the nature of things, hope to long possess. The trade of all parts of the American continent can be thrown open to the people of North and of South America by means of a great intercontinental railroad. Such a railway would not only distribute the commodities of one part of the American continent over every part, one may almost say, of a hemisphere, but would be the means of spreading a vast amount of intelligence among the people. It would evoke, as if by magic, a great number of new industries and cause vast areas of virgin territory of unsurpassed beauty to smile with the rich fruits of the earth. It would, in many instances, arouse dormant energies of many people, and some of the parts of the American continent which are now lying waste would be found to be rich in natural resources of well nigh priceless value.

Although the railroad system of the United States is already immense, every year it is enlarged at the rate of thousands of miles. An intercontinental railroad aided by wise statesmanship would be instrumental in unifying to a large extent the commercial interests of a continent. All parts of South America, by means of a railroad, could be practically brought far nearer to New York than was New Orleans to the city of Washington when Louisiana was purchased by the United States. The American isthmus may be expected, if not dominated by European government, to become a highway over which a vast American commerce will pass to and fro with a speed such as has never been equaled by the swiftest of steamships.

The construction of a great American intercontinental railroad may become to the republic of the United States, as far as its commercial relations with South America are concerned, of vastly more importance to it than is even an interoceanic canal across the American isthmus. An interoceanic canal would indeed bring a part of the western coast of South America thousands of miles nearer to the ports on the Atlantic seaboard of the United States, but it would also help European nations, with their vast ocean marines, to compete with vessels of the United States for the trade of the western coast of South America. But the trade of the western coast of South America must necessarily be small compared with the traffic which would reward the construction of an intercontinental railroad. The physical geography of South America is such that not one of its important rivers, unless perhaps a single river might, to a limited extent, be thus characterized, enters the Pacific ocean. A chain of mountains running lengthwise with the western coast of the continent so cuts off its people from communication with the Pacific ocean that the commerce of its western shores is small compared with its trade on its Atlantic seaboard. It has been estimated that the area of land which would be commercially reached by ships visiting the western shores of South America would amount to but about 427,000 square miles, or an area only about six and one-half per cent. of the area of South America. Indeed, a gentleman who has carried on business in South America, and has given much study to its commercial affairs, has calculated that as far as ports on its western coast are concerned, only about four and one half per cent. of the people of South America could be commercially reached by means of an ocean marine. It is indeed true that the commerce which is carried on between Europe and South America is immense, but it is well for American statesmanship to realize that all the merchant vessels of the world can do no more than visit a port here and there on the Atlantic or Pacific coasts of South America, or to here and there ascend great rivers. They can only do the fraction of the vast business which an American intercontinental railroad entering the heart of the South American continent, and having great branches, as well as forming junctions with great rivers, would be enabled to transact.

Should the American isthmus, which is itself a vast and beautiful territory, be used as a great natural bridge for a great American trunk railway, uniting the railroad systems of the entire American continent, the commercial advantages which the people of the United States, in common with all American powers, would enjoy may well be called inestimably great. To the people of the United States the interior of a continent about twice the size of Europe would be suddenly thrown open for trade. In a few days to a fortnight merchandise could be borne by an overland route between the most distant parts of the American continent. The people living along the entire route of the road could have borne to them every commodity that commerce could bring to them. Let one contrast a journey in palace cars through a land of well nigh Eden-like beauty with a journey by ship from Europe to South American ports, a journey which would always be liable to the dangers of ocean travel. The mails of the United States, as well as merchandise, would pass between the United States and South America with regularity. As water to a thirsty soil, so would be such a railroad to vast stretches of superb territory. Peace, intelligence, public institutions of learning, civil and religious liberty, in short, a thousand blessings would be evoked along the route of the railroad. People living in cities and states widely separated would be made neighbors. Well might the people of an entire continent unite in rejoicing over such a great blessing to themselves and to their posterity as such a railroad might justly be expected to become.

Should it be asked, "What can be done by the conference of representatives of American powers which is to meet in Washington next October to help forward such a great enterprise as the building of an intercontinental railroad?" one may be permitted to point out that before the building of such a railway is begun it may be well for the governments which are to be represented at Washington to take various preliminary steps toward making the enterprise practicable and toward enabling it to accomplish for the people of America all the good which it should be made to accomplish.

It is, perhaps, not too much to say that should the delegates unite upon a wisely drawn bill, providing for a railroad which would bring to each other the most distant parts of a continent—a suitable bill to submit for improvement and for ratification to their respective governments—the question of uniting North and South America by a great overland railroad would be presented in a suitable manner to the people of America. Should a plan be devised by which the powers which are to be represented at Washington would unite in saying, "Let there be such a railroad!" there will soon, as if by magic, be such a railway.

The politician of a day, whose statesmanship can scarcely extend beyond the State in which he lives, may be appalled at the greatness of such an undertaking as that of constructing a railroad to bind together the most distant parts of an entire continent.

But even a thoughtful American citizen may well be amazed as he reflects how easily such a great work could be accomplished if aided by wise statesmanship.

Among the questions with which statesmanship will have to deal when helping to make possible the construction of a railroad running north and south through the three Americas will be, "How shall assurance be given to a properly organized company that all the governments through whose territories the railroad will pass will grant a right of way to the iron horse?"

This question would be, to a good degree, happily answered should the governments which have been invited to be represented at Washington enter into treaty relations with each other, not only to grant a right of way to the iron horse and its train, but to offer inducements to the building of the railroad by making to it land grants, and by agreeing to whatever judicious measures would facilitate traveling by railroad. It would be very desirable that states should agree upon wise custom house regulations, so that travelers and merchandise would not be detained as they pursued their long journey across the imaginary boundaries.

States could agree that no duties should be charged on merchandise which was merely transported by rail across their territories. Perhaps the happiest of all results would flow from an agreement by all American

powers to enjoy among themselves perfect free trade and to only collect duties at their ports.

In time they might even divide among themselves, on a fair basis, the custom house receipts collected at their ports, thus removing any loss which might in any case be supposed to arise from the adoption of a system of perfect free trade between all American states. Each state through whose territory the great railway would pass could not only agree to protect the road within its boundaries from highway robbery, which of course it would do, but could also agree to various laws by which civil liberty would be secured to travelers in case of what are known as railroad accidents.

Should an international code of laws be framed for the great intercontinental railroad, perhaps various provisions might be made which would make traveling on the great railroad so safe and enjoyable, and would be so just, and yet so encouraging to railroad traffic, that the road could hardly help doing, from the moment it was completed, a prosperous business.

Should a war unhappily break out between American powers, the railroad could be considered as neutral ground not subject to attack or to unreasonable molestation from any source.

"What would be the cost of constructing a railroad to unite the three Americas?" is a question which may well suggest the importance of the American powers agreeing to unite in at once taking proper measures to employ competent engineers to survey suitable routes for the road and to make at least rough estimates of its probable cost.

Until surveys are made for the road one can scarcely do more than guess how much money would have to be raised to build it. Should $200,000,000 have to be expended in building the road, the money would be largely expended in constructing embankments and in removing barriers of rock and in making tunnels and in building bridges, in short, in making what may be called great permanent improvements of a public nature which would be a splendid legacy to posterity. It would be spent in a manner which would vastly increase the value of immense tracts of territory. It would be largely spent in enriching America.

There is a way in which the government of the United States could constitutionally aid—and that in a manner which might be immensely advantageous to the United States—the construction of a great American intercontinental railway. It could enter into treaty relations with the American powers by which they would, in consideration of the United States insuring the construction of the intercontinental railroad by guaranteeing the interest on railroad bonds for a limited time, give the United States very satisfactory equivalents in the form of various much to be desired treaty stipulations.

It would be a very easy matter for the government of the United States to secure all the money needed for an intercontinental railroad. Suppose that two or three hundred or even more millions of dollars should be needed to unite the material interests of Central and South America to those of the United States. Even a people as rich as are the people of the United States might wisely perhaps hesitate before locking up such a large amount of capital too rapidly in a railroad, lest their doing so should be followed by what are called "hard times." But the government of the United States could guarantee say four per cent. interest on the bonds of the railroad for fifteen or twenty years—unless, as might justly be expected, the road should become self-supporting at an early period. The government could in a provident manner insure the obtaining of large sums of money for the road from the money markets of the world. The United States could make such guarantees on condition that the United States mail should be carried in an expeditious and satisfactory manner by the great railroad.

The government of the United States will naturally have a deep interest in a railroad uniting the three Americas. It would not wish it to become a giant monopoly, charging what it pleased for transporting American commerce. It would not look with satisfaction upon this railroad having a charter which would enable it to become a great European corporation—even its stock owned, it might be, by European governments who could appoint directors who would not be American at heart, but would be disposed, in the interest of European governments to levy such tolls on American merchandise that merchants of the United States, in many instances, would be unable to compete with Europeans for a very valuable trade. In perhaps no way could the United States government, as the leading American power, be better able to wisely regulate the price of freight, exercising a just control over it—a very important matter—as well as by having a voice in its management by duly aiding it.

Many American citizens may well be amazed as they contrast how little the government of the United States has done, compared to what other governments have done, to open up great avenues of trade, such as building for commercial or military purposes great roads.

Many, and one might even say wonderful, were the great roads built by the Roman empire. A transcontinental railroad has been rendered a possibility by the great aid rendered to it by the Canadian government. In India, Great Britain has guaranteed the interest on literally hundreds of millions of railroad bonds, bonds of railroads which are now self-supporting. Great railroads have been built by the government of Russia. The Argentine Republic, one of the most prosperous of American states, owes to no inconsiderable extent its wonderful prosperity to the aid which its government has rendered its people by encouraging them to build railroads. The railroad system of South America is already vast, and is ever and anon creeping northward to join the railroad system of North America. Eager, indeed, would be some of the governments of Europe to obtain, could they do so even at the cost of great outlays of money, the vast commercial and political advantages which the republic of the United States could easily obtain, at an outlay small indeed, by aiding in fitting ways in securing the construction of a railroad which would unite the material interests of the three Americas; a railroad over which streams of wealth and of life-giving prosperity would flow to all parts of the American continent. The construction of such a road could probably be insured should the government of the United States enter into treaty stipulations with sister American states to guarantee four per cent. on two hundred millions of railroad bonds, or say at an outlay for a limited number of years of about eight millions of dollars a year. The completion of such a road may well be expected to mark a new and grand era in the commercial prosperity of the western hemisphere.

At the conference of delegates from American governments which is to meet at Washington in October there will be representatives of two governments which will naturally not take the same degree of interest in the building of an intercontinental railroad as will other American powers. These representatives are the ones which come from Hayti and San Domingo. The great and wondrously beautiful island from whence they come should be bound—and as a result of the conference, it is to be hoped will be bound—to a greater extent than ever before, to the republic of the United States by American lines of fast vessels. General Grant, with a military and statesmanlike eye, longed in his day, as did the people of San Domingo, and as the people of America are likely to do more and more as time goes by, to see San Domingo bound by the closest ties to the republic of the United States.

Certainly the aims of the conference of representatives of American powers which is to meet in Washington in October are noble. The influence which this conference may be enabled to exert on the destiny of the American continent and upon its adjacent islands is sublimely grand. Senator Frye, whose name is especially identified with the calling of the conference, deserves not only to be congratulated upon his success in bringing about such an important gathering of representatives of American states, but to receive the thanks of the people of a continent. Everywhere that the delegates to this historic conference shall go may they be received with hospitality, and may many of them bear back with them to their homes—widely separated indeed, now, but destined, it may be, within a few years' time, to be brought near to each other by means of a great intercontinental railroad—the happiest of remembrances of their visit to the republic of the United States.

JOHN C. HENDERSON.

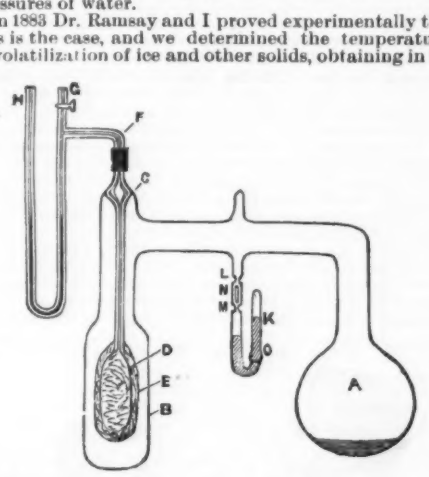
APPARATUS TO ILLUSTRATE THE INFLUENCE OF PRESSURE ON THE VOLATILIZING POINT OF ICE, AND OTHER PHENOMENA.

By Prof. SYDNEY YOUNG, D.Sc.

IT was first observed by Carnelley that when a block of ice with a free surface for evaporation is exposed to pressures lower than 4·6 mm. it cannot be melted, no matter at how great a rate heat is supplied to it by radiation.

At a meeting of the Owens College Chemical Society, eight years ago, I suggested that the maximum temperature to which ice can be heated under any given pressure lower than 4·6 mm. could be ascertained from the curve representing the vapor pressures of ice at different temperatures, just as the boiling point of water under any pressure is given by the curve of vapor pressures of water.

In 1883 Dr. Ramsay and I proved experimentally that this is the case, and we determined the temperatures of volatilization of ice and other solids, obtaining in the following year an experimental proof of the fact previously predicted from thermodynamical considerations by Prof. Kirchhoff and Prof. James Thomson, that the vapor pressure of a substance in the solid state at a temperature below its melting point is lower than that of the substance in the liquid state at the same temperature.



Inasmuch, however, as a good pump is required to reduce the pressure sufficiently, and as the experiment by which these facts are proved is in other respects rather troublesome, it has not, I believe, been usually admitted in an ordinary course of lectures.

It seems possible, therefore, that an apparatus which I have constructed to illustrate the effect of pressure on the volatilizing point of ice may prove useful to other lecturers, more especially as it serves to illustrate some other interesting points. The apparatus is a modification of Wollaston's cryophorus and of that employed by Dr. Ramsay and myself in our investigations. The bulb, A, is similar to that in the cryophorus, but in place of the second bulb there is a wide cylindrical tube, B. At C is fused a tube of narrow bore (say 1 mm.), to which is sealed a wider tube, D, closed at the end.

This tube contains air, and acts as an air thermometer; it is covered with cotton wool, which is to be saturated with water before beginning the experiment. The narrow tube is open at the upper end, and is connected by an India rubber tube with the gauge, F G H, which contains sulphuric acid colored with indigo as an indicator. The gauge is open at both ends, but is provided with a stopcock at G.

As in the cryophorus, the apparatus must be absolutely free from air, and the cotton wool should be well washed with alcohol and ether to remove all grease, otherwise it may be difficult to saturate it with water. The pressure in the apparatus may be indicated by a mercury gauge, K, but obviously both the construction and the manipulation of the apparatus are rendered somewhat less easy by the addition. The gauge, if added, should have a circular constriction at L and a flattened constriction at M, a narrow tube, N, closed at both ends, being placed in the tube between the constrictions.

When the apparatus is in its usual vertical position, the little tube, N, rests on the flattened constriction, and there is free communication between the gauge and the rest of the apparatus; but when in the transference of water from one bulb to the other the apparatus is inverted, the tube, N, falling against the circular constriction closes the tube and prevents the escape of mercury from the gauge. For further security an air or vapor trap may be placed at O.

Description of Experiment.—The cotton wool is thoroughly saturated and the rest of the water is then transferred to the bulb, A. The gauge is connected with the air thermometer and the stopcock closed. The bulb, A, is then immersed in a beaker of water cooled by a little ice; the diminution of pressure in the apparatus, consequent on the lowering of temperature, is at once indicated by the mercury gauge, and as the boiling point of water is lowered by reduction of pressure, the temperature of the air thermometer is at once seen to fall. (The bulb, B, may be heated by boiling water or to any desired temperature during the whole experiment.) When, by further addition of ice, the temperature of the bulb, A, sinks to 0°, the pressure in the apparatus—if air has been completely expelled—falls to 4·6 mm., and the temperature of the air thermometer becomes constant. The stopcock is then opened so that the sulphuric acid may be at the same level in both limbs at this temperature, which is afterward shown to be 0° C.

If we now replace the beaker of ice and water by a freezing mixture at —5°, the pressure in the apparatus will be still further reduced, and the temperature of the air thermometer will again fall, but the water will not freeze. We can therefore show—I find with perfect certainty—the cooling of water below 0° without freezing, and also the reduction of the boiling point of water below 0°.

When the temperature is still further reduced by substitution of a colder freezing mixture, the water in A solidifies, and it will be seen that after the temperature of the air thermometer has fallen a little lower for a moment or two, it suddenly rises to the zero point already determined. After remaining constant for some time, until the whole of the water on the cotton wool is frozen, the temperature falls rapidly, and it is now found to depend solely on that of the bulb, A, even though the bulb, B, be strongly heated.

A third determination of the zero point may lastly be made, if sufficient ice remain on the cotton wool, by removing the freezing mixture. The temperature of the air thermometer slowly rises to 0°, and remains again at that temperature until the ice is melted.

The following facts are therefore clearly demonstrated by means of this apparatus: 1. That the vapor pressure of water (and of ice) depends on the temperature, and that the boiling point (or the maximum temperature to which water with a free surface for evaporation can be heated) depends on the pressure. 2. That the vapor pressure of water at 0° is 4·6 mm., and that under a pressure of 4·6 mm. water boils at 0°. 3. That the boiling point may be reduced below 0°, the water remaining liquid, but that when solidification begins the temperature suddenly rises and remains constant for a considerable time (it is assumed that this temperature is 0°). 4. That the volatilizing point of ice, like the boiling point of water, depends on the pressure, and that if the ice has a free surface for evaporation the walls of the vessel surrounding it may be strongly heated without affecting its temperature.

Many of these points may be proved, though not in all cases so directly, without the mercury gauge. The apparatus is a little troublesome to construct, but once made, the experiments may be conducted with almost as much ease and with quite as much certainty as that with Wollaston's cryophorus.—*Chemical News.*

ZEISS' APOCHROMATIC OBJECTIVES.

By Dr. OTTO ZACHARIAS.

THE perfecting of the system of homogeneous immersion has been followed by another triumph, by which a new instrument has been provided for the biologist which he will scarcely be able to dispense with in the future in any delicate histological investigations. This is a wide aperture objective, most carefully constructed according to Prof. E. Abbe's directions, which may, on account of its increased achromatic qualities, be shortly designated as apochromatic. The construction of this new system of lenses was only actually realized a few years ago, after experiments extending over more than ten years. This delay is explained by the fact that the new idea could not be carried out without the assistance of the glassmaker, who was unable to supply a material which fully satisfied the conditions imposed by theoretical considerations. A glass was, however, at length obtained on the large scale by the application of phosphoric and boric acids (in addition to silica, which was formerly the only substance used), which fulfilled all the requirements of the practical optician. A large laboratory has been erected specially for the study and manufacture of optical glasses, by Zeiss, in Jena, and has been placed under the direction of Dr. Schott. In this institution all kinds of glass used for optical purposes is produced, of excellent quality and uniformity. The different varieties are supplied to all German and foreign opticians, all novelties introduced by Zeiss being open to unlimited competition.

I propose in this article, first of all, to briefly explain the principle upon which the construction of these apochromatic lenses is founded, and then to communicate the experience I have gained of them in practical microscopical work during a period of more than six months.

As regards the first point, I avail myself, for the purpose of explanation, of Prof. Abbe's own exposition, and only propose to communicate the quintessence of it to a larger circle of readers. In judging of the capabilities of the new objective, on the other hand, I rely entirely upon my own opinion, which has been gradually formed during my almost daily work with the new system.

I hope by means of this communication to perform a small service for the numerous interested individuals who have hitherto had no opportunity of testing the lenses themselves. The construction of perfectly achromatic objectives has hitherto failed on account of the

great inequality in the dispersion of different colored rays which is characteristic of ordinary crown and flint glass. The so-called secondary spectrum was never completely prevented, it being caused by the fact that under ordinary circumstances only two different colors of the spectrum can be brought into coincidence. A similar lack of success attended all attempts to remove the very serious spherical aberration for more than one color, so that all systems of lenses have hitherto had the fault of possessing a greater or less inequality of chromatic correction between the center and the border of the field of view. These evils necessitated the employment of feeble eyepieces with objectives of wide aperture, because the errors of correction naturally became more prominent as they were more strongly magnified. Owing to this circumstance it has been customary to obtain the magnified image by objectives of very small focal length, and to obtain these as well as possible through a weak eyepiece.

The new achievements in glass making have rendered it possible to produce crown and flint glass in which the dispersion is nearly constant for all parts of the spectrum, and by the use of which, therefore, the secondary spectrum is completely done away with. In addition to this it is now possible to increase the number of optical glasses, so that with a constant index of refraction a considerable range of dispersion can be obtained, and inversely, with constant dispersion a wide range of refractive index. The fact of chief importance is, however, that the chemical composition of the new varieties of glass permits high refractive indices to be obtained not only with high dispersion (in flint glass), but also in conjunction with low dispersion (in crown glass). This result was quite unattainable by the use of silicates alone. The proper employment of the new varieties of glass prepared by the aid of phosphoric and boric acids has now rendered it possible to avoid the defects previously mentioned, and to construct objectives by means of which the compound microscope is raised to a very high degree of perfection. This is a new and brilliant result of that fruitful combination of theory and practice which has always been carried out in the enterprises of Zeiss, and which, especially through Professor Abbe's valuable co-operation, has become an example to all other optical institutes. That which immediately characterizes the new objectives is the purity of color and brightness of the image. A careful examination of them, however, shows that they possess the far more important property of picturing the object much more accurately than was possible with the old construction, this improvement being due to the almost complete removal of all the errors arising from the dioptric relation of different colored rays. The definition given by a good apochromatic objective—for example, of caryo-kinetic figures—is so remarkably good that work with any system not possessing this superlative excellence becomes henceforth wearisome. This praise may perhaps sound excessive, but it only represents the actual state of affairs, and may at any time be confirmed by a suitable test object.

I have availed myself of the use of these new lenses chiefly in the revision of my researches on the mitosis of the egg of *Ascaris megalocephala*, and am compelled to affirm that they are practically indispensable for this and similar classes of work. A further advantage of these objectives, and one which cannot be too highly praised, is that they permit of the use of very powerful eyepieces. Consequently a system of 2·5 to 3 mm. focal length now performs the same work, aided by powerful eyepieces, as one of the old objectives of much less focal length; it is, for example, possible to obtain a total magnifying power of 1,200 with an objective whose magnifying power is 80–100, the rest being done by the eyepiece. The catalogue published by Zeiss in 1887 gives full information about the prices of the new objectives, which are certainly somewhat dear. At present 6 dry objectives, 1 water immersion, and 3 homogeneous immersions are constructed as apochromatics for scientific purposes. The set of objectives employed by me consists of 1 dry objective of 16 mm. focal length (0·30 aperture), a second similar glass of 4 mm. focal length (0·95 aperture), and a homogeneous dispersion of 2 mm. focal length (1·30 aperture), the price of the whole amounting to 680 marks (£34). The second of these is provided with an adjustment, since it only yields its full work when used with a cover glass of the proper thickness. The immersion objective, on the other hand, is only supplied in a fixed mounting. These glasses give the finest results when a cover glass 0·16 mm. thick is employed with them. The wished-for sharpness of definition can, however, readily be obtained by shortening or lengthening the tube, according as the cover glasses are thicker or thinner than this mean of 0·16 mm.

Special eyepieces are also being manufactured for the apochromatic lenses, and are a further assistance to observation. In all objectives of considerable aperture (in which the front lenses cannot themselves be achromatic) there is always color present, except in the very center of the field, so that at the borders of it distinct colored bands can be seen. This defect cannot be perfectly remedied even in the apochromatic lenses; but since in this case the amount of deviation is about the same for all parts of the aperture, a correction can be introduced by means of the eyepiece. If this be constructed so as to be to a definite extent not achromatic, the error of even wide aperture lenses can be thus compensated and a pure image produced in every part of the field. The eyepieces in question are therefore termed "compensating eyepieces." It is particularly to be observed that they do not interfere with the use of the camera lucida.

Microphotography is naturally greatly assisted by the new apochromatic lenses. Convincing evidence of this is afforded by the special catalogue, illustrated with numerous examples, published by Zeiss in 1888. Lenses accurately corrected, spherically and chromatically, are now constructed by Zeiss for photographic purposes and have received the name of projection lenses. As regards this particular branch I have personally no experience, but celebrated specialists in microphotography have already expressed the most favorable opinion of the new lenses. The photogravures of pleurosigma angulatum given on Table V. of the catalogue referred to above are, as must be conceded by every one, of admirable truth and sharpness, so that conclusions may hence be drawn as to the capabilities of the lenses used for their production.—*Biolog. Centralbl.*

HOW DEAF-MUTES ARE TAUGHT TO SPEAK.

OUR readers already know that the method of signs, which, in the time of Abbot de l'Epie, was held in deserved esteem, has been abandoned for some time. Since then, science has advanced. The abbot himself foresaw this progress, for he declared that the deaf-mute would never be completely restored to society until the day in which it would be possible for him to express himself *viva voce*, and read conversation from the motions of the lips.

An *exposé* of the new method, called the oral method, because speech is the object that it has in view, is to be found in an interesting book recently published by Mr. L. Goquillot under the title that heads this article.

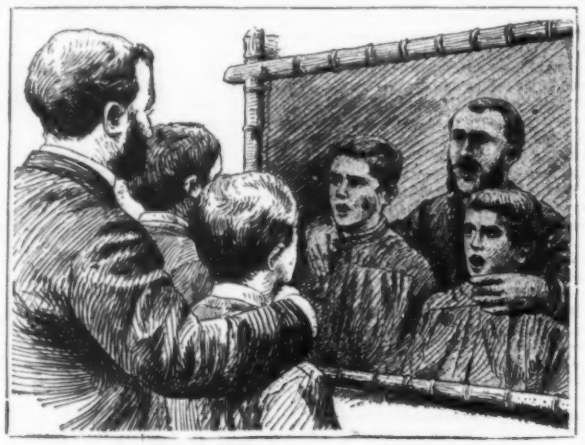


FIG. 1.—EXERCISING THE TONGUE AND LIPS OF A DEAF-MUTE BEFORE A MIRROR.

Mr. Felix Hement, in the course of an article in this journal in which he gave the history of the question, has said that the deaf-mute is mute only because he is deaf. Therefore, it is not, as we have generally been led to believe, on account of a malconformation of the vocal organs that he does not speak. There is no lesion of these, and there is nothing to oppose the re-establishment of their functions.

The first question to solve is this: Since deaf-mutes are incapable of perceiving speech by the ordinary way of hearing, how can they be made to perceive it? In order to answer this question, it is well to examine how the phenomena of speech are decompounded. The observation of facts shows us that speech is a compound of two classes of phenomena—motions and noises. To be caught, the first have no need of the aid of hearing. Sight, then, will suffice for the perception of this first order of facts. Noises, on the other hand, transmit, in the regions where they are produced, vibrations that may be perceived by the touch. Sight and touch, combined, will thus suffice to make up for the hearing that is wanting. The reader may satisfy himself of this by standing in front of a mirror and pronouncing the vowels *a*, *é*, *i*. He will see at once that the mouth closes more and more in going from *a* to *i*, the opening of the lips for *é* being just of intermediate dimensions between *a* and *i*.*

So too with *a*, *o*, *ou*, and with *a*, *eu*, *u*. This is what young deaf-mutes are made to observe by placing them before a mirror, and making them practice the art of arranging their lips to produce each sound (Fig. 1).

This is not all. When we pronounce the vowels *a*, *o*,

FIG. 2.—SHOWING THE VIBRATIONS OF ADAM'S APPLE.

ou, *é*, *i*, *eu*, *u*, the lips are not alone in play; the larynx proffers a sound.

This sound causes a vibration of the cartilages of the larynx, and principally of the thyroid, which is commonly called Adam's apple. It suffices to put the hand on the latter while one is speaking, in order to ascertain this. This is what the deaf-mute is made to do (Fig. 2). So, then, guided by sight for the visible part of the vocal phenomena, and by touch of the tangible part, he has in these two senses a means of perceiving each of the elements of language, one after the other. When he is in possession of all the elements, which are reduced to 30, he has only to couple them in order to form syllables, words, and phrases.

But the thing is not so simple or so rapid as we seemingly make it. Before proceeding to the teaching of the phonetic elements, it is necessary to make a young deaf-mute perform a long series of exercises designed to put his lungs, larynx, tongue, lips, eyes, and touch in a state to operate as required for talking and for perceiving speech. This series of exercises is called the preparatory period.

It seems strange, at first sight, that it should be necessary to put the lungs, larynx, tongue, lips, etc., in a state to operate. Yet it is necessary. In the individual who has never spoken, the lungs are accustomed to operate for respiration only. Each inspiration draws into the lungs but about 30 cubic inches of air, on an average, while for speaking it is necessary to inspire at least 120 cubic inches.

FIG. 3.—REGULATING THE RESPIRATION BY TOUCH.

It is therefore necessary to put the mute through this course of pulmonary gymnastics, which with us is performed unconsciously, but which he would not perform without special training (Fig. 3). What would happen were the inspirations not thus regulated? Vulgarly speaking, the mute would be too short-winded; his speech would be jerky, and hence disagreeable, and not very intelligible. It would likewise be too feeble, or be discordant, if the larynx were not exercised a little, as this organ, when it has not operated, is, so to speak, in a rusty and enervated state. So, too, the tongue, that has served but to roll food about in the mouth and force it into the œsophagus, needs to be habituated to produce the special motions that it will have to perform for the formation of sounds or the articulation of consonants. Finally, in the mute, the lips have not, and never will have, even after long and numerous exercises, the suppleness that they have acquired in those who have spoken from infancy. These exercises in rendering the tongue supple are performed before a mirror. As for the eye of a deaf-mute, that is necessarily more mobile than in the ordinary run of people, because it is desirous of taking in everything that occurs, and through its inquisitive mobility makes up for the absence of the information that hearing would furnish. It is necessary to make it acquire greater fixedness and a more continued attention, which is constantly directed to the lips of the interlocutor. It has been observed that the sense of touch is less delicate in deaf-mutes than in other children. To this, too, through special exercises, has to be given the fineness that it should have in order to seize the vibrations that accompany sounds.

Thus this preparatory period may be compared to the prelude executed by a musician upon his instrument in order to tune it before playing upon it. Without such prelude, the former would run the risk of producing only more or less discordant notes; without this preparatory period, the phonic instrument of the deaf speaker would not be sufficiently tuned for operating well.

The instrument being thus prepared, sounds are drawn from it. First, it is the sound *a*, which is con-

* It should be understood that in these examples the vowels have the sound that is assigned to them in French.

sidered the simplest to emit. In fact, in order to produce it, it suffices to open the mouth without contraction of the lips or tongue, and to cause the larynx to vibrate.

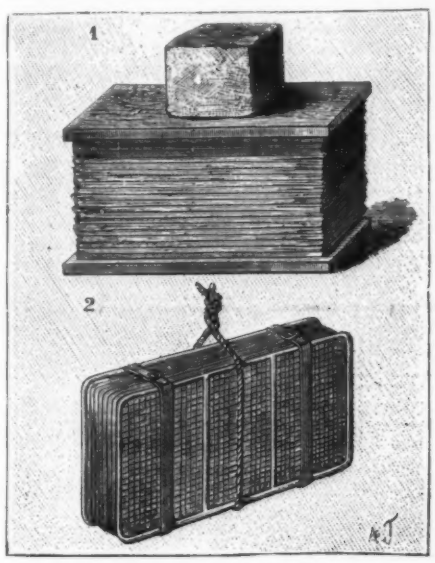
One proceeds next to the teaching of the more difficult sounds, such as *o*, *ou*, *è*, *é*, *i*, *eu*, *u*, always with the aid of the sight and touch. The child is made to observe, for example, that a sheet of paper or the flame of a candle does not move when the vowels *a*, *o*, *é*, *i*, are pronounced before it, but that it is strongly repelled when *ou* and *u* are pronounced. Moreover, with *i* it is shown that very sensible vibrations are produced over the head.

Mr. Goquillot gives a very minute and precise description of the organic motions necessary for the production of each phonetic element, and for each of these elements he publishes figures giving the aspect of the face, an anatomical section of the organs, an inscription of the points of contact of the tongue with the roof of the mouth, and a sketch representing a professor in the act of making a child effect all the necessary motions. In looking over this collection of figures, a person is truly as if he were in a school room, and quickly gets a pretty accurate notion of the processes employed for teaching deaf-mutes to speak. It is consoling to reflect that, owing to patient researches and penetrating analyses, we are now succeeding in rendering nearly our equals those whose infirmity formerly relegated to the rank of pariahs, and who but recently could be understood only by their companions in misfortune or by a few initiated.—*La Nature.*

THE GATHERING OF PLANTS FOR THE HERBARIUM.

Preparation of Plants.—As soon as one has returned from a botanical excursion, the first thing he ought to do is prepare the specimens collected. He should never defer this until the following day, unless he wants to see his specimens more or less damaged. In case the thing is impossible, the best thing to do is to leave the plants as they are, in the box, and put the latter in a cool place.

For the preparation of phanerogams and ferns, mosses and other cryptogams of a more or less dry



FIGS. 1 AND 2.—PLANT PRESSES.

texture, we proceed as follows: We should have on hand a large quantity of common yellow (straw) paper, which is now preferred to the unsized gray paper formerly used, and which has the advantage over the latter of drying rapidly, because it absorbs humidity less easily. It is of a firmer consisteney, too, and this gives the specimens more rigidity. Finally, it is much cheaper, and this is a further consideration. This paper should be of the size that has been adopted for the herbarium. Driers should be prepared beforehand by putting five or six double sheets one within the other.

A package of driers and a package of double sheets is placed on one side and the botanical box on the other. We then take a drier and lay upon it an open double sheet. The plants should be arranged on the latter in such a way that they shall preserve their natural aspect as nearly as possible, and they should not lie over one another.

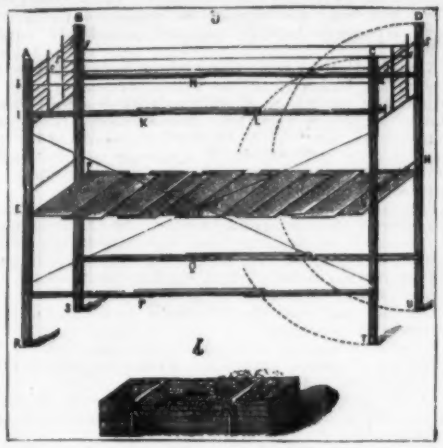
The specimens should be accompanied with the tickets that were fastened to them in the field. The sheet, having been folded, is covered with a drier, upon which another sheet is to be laid and provided with specimens; then another drier is placed in position, and so on, care being taken to arrange the large specimens alternately from one side to the other so as to balance the package well. When the latter has reached a height of say 12 in., boards designed to sustain it are put on top of and beneath it. As many packages are to be made as are necessary to exhaust the gathering. Each package must then be submitted to a strong pressure. For this purpose, presses of different styles have been devised. The simplest method is to load each package with large stones or other heavy objects, which have the advantage of exerting a continuous pressure in measure as the package shrinks.

The next day, the driers, which will have absorbed a portion of the water contained in the plants, are removed from each package and replaced by dry ones, and the packages are again submitted to pressure. In doing this, it is not necessary to touch the specimens. The sheets are used just as they are to form new packages, care being taken simply to straighten out the leaves that have become folded. The damp driers are left to dry, so that they can be used over again.

* Continued from SUPPLEMENT, No. 702.

After the plants have parted with most of the water that they contained, it is no longer necessary to submit them to so strong a pressure. As the packages are looser, the air circulates between the sheets and removes what humidity remains.

On the first day, the driers should be changed in the



FIGS. 3 AND 4.—APPARATUS FOR DRYING PLANTS.

morning and evening. On the following days, a single change will suffice.

The desiccation of plants is facilitated by spreading the sheets containing them around in a dry and well aired place, before putting them under pressure again. In order to hasten the preparation still further, an apparatus called a wire press (Fig. 2) is used. This is formed simply of two wire gauze frames, between which may be arranged twenty folios without driers, after the plants have been pressed sufficiently to cause them to give up most of the water that they contained. The package is fastened with straps and suspended in the sun or before a fire in a dry and well aired place. This system gives the best results, provided that too large a number of specimens is not put in each package, in which case those in the center would get rotten.

The fact must be recalled that plants are so much the better prepared, and better preserve their colors, in proportion as the driers are often changed and the desiccation is more rapid. A specimen is sufficiently dry when it has become rigid and does not feel damp to the touch.

The botanist, on an excursion, is often annoyed by want of a place to make his preparations. The small size of hotel rooms renders it very difficult to spread plants out and to dry damp driers. In the Bulletin of the Botanical Society of France (vol. xxx., 1883), Mr. Vallot has described an apparatus which, to a certain point, permits of obviating this inconvenience (Fig. 3). It is simple and light in construction, and is easily mounted and carried. A package may be made of all the pieces that constitute it, and in this form (Fig. 4) it takes up very little space with the baggage.

The preparation under consideration, as we have described it above, is adapted to small, thin, and easily dried specimens, but there are others that require certain precautions before being put under pressure. Thus the too thick parts, roots, tubercles, bulbs, etc., should be rendered thin by means of a very sharp knife, care being taken to see that the part that remains sufficiently represents the complete organ (Fig. 5).

Bulbous plants will continue to vegetate in the herbarium, owing to the nutritive materials stored up in their subterranean parts. To prevent this, it is necessary to immerse them for a few minutes in boiling water. An immersion of about twenty minutes in a bath of alcohol or vinegar likewise gives excellent results. For succulent plants, such as sedum, sempervivum, etc., the same precaution is necessary. Specimens that are too large should be divided, and every fragment be dried separately, with one number common to all.

There are fleshy flowers that it is difficult to preserve in a herbarium. Some of these should be detached and preserved in alcohol. The same method is applicable to flowers with a complicated structure, which in this

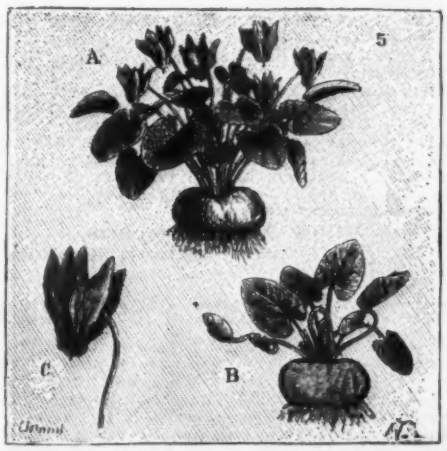


FIG. 5.—MANNER OF CUTTING PLANTS.

state of preservation are more easily studied. Such is the case with certain orchids.

When the inflorescences are very dense, the flowers cover one another when they are put in the press, and they become black and often finally rot. A good way of preparing such flowers is to detach some of them and dry them separately.

When the inflorescences are too voluminous, as happens with the capitula of certain compositæ, it is indispensable to split them in order to facilitate their desiccation.

Certain plants, such as the grasses, ferns, etc., dry much more rapidly than others. It is necessary on changing the driers to examine the specimens carefully and to remove them in measure as they are found to be in a proper state of dryness. The dried plants are kept in packages until they can be introduced into the herbarium. If one is on an excursion and wishes to ship them, it will be necessary to affix to each one a ticket containing the notes taken in the memorandum book. The plants should be packed in tight boxes, that one should order to be put in a place free from humidity during the trip.

The ferns, lycopods, horsetails, rhizocarps, mosses, liverworts, lichens, a goodly number of fungi, and the characeæ are prepared as we have just described. The fleshy fungi that cannot be dried are to be put into alcohol after a colored drawing of them has been made. For the preparation of seaweeds, see the pamphlet by Dr. Bornet, which we have already spoken of.—*D. Bois, in La Nature.*

ODORIFEROUS INSECTS.

MR. G. A. FARINI, in his work entitled, "Through the Kalahari Desert," relates the following interesting fact, which may possibly put some of our readers on the track of a new perfume:

"Three days' easy going brought us to Ghanze without any notable incident. As we drove to the water, the fore-wheel of my wagon crashed into a bush, which at once gave out a *powerful and delicious* perfume. Jumping down to examine the cause, I plucked some leaves, but found they were scentless, as was also the stem of the plant. I could not make out where the pleasant odor came from until I touched a small *beetle*, when out came a puff stronger than ever. The little bug was an animated perfumery store, emitting the delicious scent whenever disturbed. I caught three of them, and put them in a perforated box, in which they lived for a week, the movement of the wagon affecting them sufficiently to make them give up their fragrance in such quantities as to keep the wagon perfumed like Rimmel's. When they died, the scent died with them."

Upon this the editor of the *American Druggist* remarks:

"It is true that the locality where these remarkable insects were met with is rather out of the way, being situated in about 21°45' S. and 21° E. (of Greenwich), between what is known as Demara Land and Khamas Land. But as the author is known to be reliable, and has brought back so many other remarkable novelties, there is no reason to doubt the existence of the 'perfumed' insect."

Commenting upon the foregoing extract in the *American Druggist* for March, Mr. J. U. Lloyd, of Cincinnati, says:

"In this connection I desire to call attention to the fact that in this country we have an insect which is probably well known to entomologists, and which is also a 'perfumed insect.' This insect is familiar to persons whose occupations bring them about the rivers and streams of this section of the country, and probably is common elsewhere. Its common name is 'write my name,' so called from the curious manner in which it runs or swims about the surface of the water with great rapidity, especially when disturbed. I do not know its proper systematic name. It is of a dark brown color, and occurs in little schools along the edges of our streams where the current is not swift. These insects, when disturbed, exhale, while young, a fruit-like fragrance, which is likened by some persons to the odor of early harvest apples, and it is quite pleasant. If they are caught and held in the hand, they impart this odor to the latter, and it seems as though the irritation excites them to emit it. When they are old, or at least very large, they exhale a much stronger, indeed an unpleasant odor."

Some additional notes on the subject are also furnished to the same journal by Mr. W. C. Wood, of New York:

"Few persons who are accustomed at all to observe natural objects can have failed to notice that many insects are perfumed, or odoriferous. The latter word is, perhaps, the more applicable, since the odor of many insects is anything but perfume.

"In the case of such as live in waste and decaying animal matter the odor is the result of their food and surroundings, but with many insects there is no such cause for it, and we must suppose that they have been endowed with a special perfume for some useful or necessary purpose. Thus we find many insects which are, apparently, protected from their enemies by their pungent or fetid odor. A small blue and yellow beetle (*Brachinus fumans*) is accustomed, when disturbed, to discharge from its anal opening a cloud of bluish vapor, accompanied by a sharp report, from which it has been popularly named the bombardier. This vapor, which is a liquid volatilized by contact with the atmosphere, has a suffocating smell, and burns the fingers quite severely if the insect is picked up. The large green beetle (*Calosoma scrutator*) which is often to be seen running over sunny places, has a very peculiar fetid odor, as have almost all the other members of that family (Carabidæ).

"With some insects their perfume seems to be useful as a sexual attraction. As an instance of this may be mentioned the case of a large black wood-boring beetle (*Prionus laticollis*), which possesses a wonderful odor, very nearly resembling that of musk. The females are more noticeable in this respect than the males, their perfume being so strong as easily to be perceived by a person when several yards distant. The pretty yellow and black striped beetle (*Cyllene robiniæ*), whose grub is so destructive to our locust trees, has a very strong and peculiar odor, which scarcely resembles any other, unless it be that of phosphorus. The beetles feed in numbers on the golden rod (*Solidago*) in September, and very much resemble the striped hornets which are also found there frequently.

"The odor of many insects closely mimics that of various vegetable substances. Thus the common brown wasp resembles in smell the vanilla and tonka beans, as do also several species of the brightly colored tiger beetles (*Cincindelæ*), which run and fly along sunny roads and shores. A large shining bronze beetle

(*Osmodermaeremita*), often found in old orchards, has the perfume of a ripe peach, and a little blue and green ground beetle (*Chlœnius nemoralis*) that of the butternut. The blackish 'squash bug' (*Coreus tristis*) has an odor somewhat resembling that of the pine-apple. This insect, when disturbed, has a curious way of tilting itself to one side and throwing out a fine spray of volatile and probably irritating liquid from pores all along its abdomen. It is sufficient, in closing, to mention one more bug, the *Cimex lectularius*, which, although best known for its blood-loving propensities, has also a peculiar and distinctive odor."

WALKING EPILEPSY.

DR. CHARCOT always retains the specialty of strange cases. The other day, at the Salpetriere, while treating of a variety of epilepsy which deserves the name of walking mania, he related the following typical instance: The patient, M., was employed in a Paris foundry to make deliveries of bronze articles in the city. He was accompanied with a driver to mind the horses and wagon, while he dealt with the customer and collected the money. For nineteen years he has been working for the same firm. On January 18, in the evening, after delivering the last lot of goods, he disappeared, leaving the driver to go back to the store alone. From this moment to January 26 the unfortunate M. lost all consciousness of his actions, when at 2 P. M. "he awoke," as he said, standing on a bridge in an unknown town, and listening to the brass band of a passing regiment. On coming to his senses, he noticed his clothes were clean, his shoes in good condition, and no bodily harm had befallen him, but all recollection of his doings was lost, and he had no idea of the place where he happened to be. Unwilling to cause remarks by asking the plain question, previous experience having taught him better, he only inquired of the way to the railroad station, and there ascertained he was at Brest, some three hundred and sixty-five miles from Paris. Now counting his money, he found he had seven hundred francs left out of nine hundred he had collected, showing he had spent forty dollars in eight days, nothing out of the way, considering the railroad journey. Thus far, so good. Only, as no train left for Paris before night, M. bethought himself, to guard against another walking fit, of placing himself under the protection of the law—a dangerous proceeding in most civilized countries. The law in the present instance appeared in the shape of a "bon gendarme," to whom M. confessed his quandary, showing at the same time several vouchers, among which a certificate signed by Dr. Charcot. The gendarme had never heard of Dr. Charcot; but with characteristic acuity, replied, "He knew that story;" and promptly locked up the Parisian. Six days were necessary to clear up the case, as the Paris house had changed hands, and the new firm being imperfectly acquainted with the man's antecedents, telegraphed at first to hold the prisoner. It was only on February 1 that M. was set free, but he lost his situation. The story is no doubt a strange one, and might lead to a different interpretation, were it not that Dr. Charcot has long been acquainted with the patient, knows him to be a temperate, steady man, married, and the father of two children, and has had him under treatment before for similar fits of unconsciousness, only less serious. The case, according to the celebrated specialist, is a form of epilepsy, and one of the reasons for the diagnosis is that the patient has been on previous occasions successfully treated with bromide of potassium. He had M. under his care for nearly four years, during which time three abscesses occurred. The bromide treatment gradually reduced the fits and their duration, to such an extent that the medicine was stopped last September. The patient was considered cured when the last outbreak took place.—*Therapeutic Gazette.*

DANGERS OF CARBON MONOXIDE.

PROF. W. P. MASON, of the Rensselaer Polytechnic Institute, contributes the following:

In Troy, N. Y., on January 6, 1887, owing to a break in the street mains, a quantity of fuel gas (see analysis below) passed beneath the frozen crust of earth and found its way into the adjoining houses. Three deaths,* and many more or less serious illnesses, resulted.

The following points, from the testimony of the physicians who made the autopsies, are to be noted:

The expressions of the deceased were placid. One victim, an old woman, was found seated in her chair holding her false teeth in her hand. The second, also a woman, lay upon the floor. The third, a man, sat upright on a lounge, his head reclining on his shoulder.

The fire was burning in the stove, and the lamps were still burning on the table. When found death had not been very recent, as *rigor mortis* was fully developed.

Very searching autopsies were made, with the result of finding nothing whatever abnormal, with the exception of the bright cherry red color of the tissues and the vivid redness and lack of coagula in the blood.

Upon opening the chest cavity the physician bent forward and took one or two long whiffs for the purpose of determining the presence of any odor. Almost immediately he was seized with giddiness and great oppression in the epigastrium, so much so that he had to discontinue his work for half an hour. The effects did not finally wear off until after an interval of about twelve hours.

The painful oppression in the chest, the giddiness and the subsequent headache experienced by this physician, call most forcibly to mind the symptoms described by Sir Humphry Davy when he so rashly experimented upon himself with carbon monoxide.

A lawsuit naturally growing out of these cases of poisoning, I was called upon to give the chemical constituents found in the said fuel gas, and the results are appended. I also experimented upon animal life with carbon monoxide mixed with air, obtaining results confirmatory of observations already made, that death usually takes place very quietly, although occasionally with convulsive movements. Chickens and rats were the two forms of life employed.

Blood, treated with carbon monoxide, I found to assume a bright red, almost carmine, color, which did not alter on exposure to air for a number of days.

Finally, in February, 1888, a bottle of blood taken from the heart of one of the victims at the time of the autopsy was submitted to me for examination. The bottle was closed with a tight cork. Although over a year old, and possessing strong odor of decomposition, the color still remained of the brilliant, vivid red noted at the time of taking the specimen. Under the microscope but very few corpuscles remained to be seen, their structure having almost completely broken down.

Examination by the spectroscope revealed the two absorption bands near the line, characteristic of the presence of carbon monoxide in combination. These bands, although very like those indicative of oxy-hæmoglobin, may yet be readily distinguished by their location only, particularly if a sample of blood artificially treated with carbon monoxide be at hand for purposes of comparison.

The space between the bands is, moreover, much less clearly lighted than in the case of oxygenated blood. As a confirmatory test, the blood under examination was treated with solid potassium sulphide, and the absorption bands found unchanged thereby—the bands of oxy-hæmoglobin, as is well known, change under such treatment to the single dark band midway between the positions of the former ones.

What is of special interest in this case is the ready detection of carbon monoxide in the blood after so long an interval of time.

At the present moment, nearly two years from the date of the accident, the blood still retains the characteristics noticed when first examined.

The analysis of the fuel gas by volume is:

CO_2	5·0 per cent.
O	0·5 "
CO	37·5 "
CH_4	0·9 "
H	48·0 "
N	7·1 "

Such gas supplied to consumers is practically odorless.

*A fourth death (that of Dwight E. Barnes, January 28, 1889) is reported from injuries received at this happening.

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